Volume 22, Number 18, September 30, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
```

Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
```

```
SHELTERS
  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl. 2)  21-8567  Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915  Nucl. News, 9: No. 12, 17-21 (Dec.
                             1966)
  22298           21-9914  Nucl. News, 10: No. 1, 17-20(Jan.
                             1967)
  23267           21-9702  Phys. Rev., 152: 1171-82(Dec. 23,
                             1966)
  23287           21-8498  Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420           21-8764  Lancet, 2: 672-5(Sept. 24, 1966)
  23474           21-8528  Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478           21-8641  Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482           21-9471  Dep. mn. CFSTI $3.00 cy, $0.65 mn
```

TABLE OF CONTENTS

Volume 22, Number 18, September 30, 1968

Category	Page
CHEMISTRY	3831
Analytical Chemistry	3831
Inorganic, Organic, and Physical Chemistry	3838
Radiation and Nuclear Chemistry	3846
Radiochemistry	3850
Separation Processes	3851
EARTH SCIENCES	3857
Geology and Hydrology	3857
Meteorology	3857
Mineralogy and Exploration	3858
Oceanography	3859
Seismology	3859
ENGINEERING	3860
Nuclear Explosions	3860
Facilities and Equipment	3860
Heat Transfer and Fluid Flow	3863
Isotope Technology	3864
Materials Testing	3866
Protective Structures	3866
Radioactive Material Handling	3867
Vacuum Engineering	3867
INSTRUMENTATION	3868
Radiation Detection Instruments	3868
General Detectors and Monitors	3868
Nuclear Spectroscopic Instrumentation	3876
High Energy Physics Instrumentation	3878
Radiation Dosimeters	3880
Radiometric Instruments	3882
Miscellaneous Instruments and Components	3883
Radiation Effects on Instruments and Instrument Components	3887
LIFE SCIENCES	3889
Biochemistry, Physiology, and Molecular Biology	3889
Ecology	3895
Genetics and Cytogenetics	3895
Health Physics and Safety	3896
Medicine	3905
Radiation Effects on Animals	3915
Radiation Effects on Plants	3926
Radiation Effects on Microorganisms	3926
Radiosterilization and Radiopreservation	3927
METALS, CERAMICS, AND OTHER MATERIALS	3928
Metals and Alloys	3928
Corrosion and Erosion	3928
Preparation and Fabrication	3929
Properties Evaluations	3930
Structure and Phase Studies	3933
Radiation Effects	3936
Ceramics and Cermets	3936
Preparation and Fabrication	3936
Properties Evaluations	3938
Structure and Phase Studies	3940
Radiation Effects	3941
Plastics and Other Materials	3941
PHYSICS (GENERAL)	3942
Astrophysics and Cosmology	3942
Atomic and Molecular Physics	3949
Cosmic Radiation	3959
Direct Energy Conversion	3961
Fluid Physics	3963
PHYSICS (GENERAL) *cont'd.*	
Geophysics	3965
Low-Temperature Physics	3974
Confinement and Heating of Plasma	3980
Diagnostics of Plasma	3981
Kinetics of Plasma	3982
Production of Plasma	3992
Stability of Plasma	3992
Thermonuclear Processes	3993
Shielding	3993
Solid-State Physics	3993
Theoretical Physics	4000
PHYSICS (HIGH ENERGY)	4003
Particle Interactions and Properties (Experimental)	4003
Electromagnetic	4003
Weak	4003
Strong (Baryon-Induced)	4004
Strong (Meson-Induced)	4005
Particle Interactions and Properties (Theoretical)	4008
General	4008
Electromagnetic	4010
Weak	4012
Strong (General)	4013
Strong (Baryon No. = 0)	4015
Strong (Baryon No. = 1)	4016
Strong (Baryon No. ≥ 2)	4019
Particle Invariance Principles and Symmetries	4020
General	4020
Applications (Electromagnetic and Weak)	4022
Applications (Strong)	4022
Field Theories	4023
Quantum Field Theory	4023
Gravitation and General Relativity	4024
Scattering Theory	4025
Particle Accelerators	4026
PHYSICS (NUCLEAR)	4030
Neutron Interactions with Matter	4030
Nuclear Properties and Reactions, $A \leq 5$	4032
Nuclear Properties and Reactions, $6 \leq A \leq 19$	4033
Nuclear Properties and Reactions, $20 \leq A \leq 89$	4036
Nuclear Properties and Reactions, $A \geq 90$	4038
Nuclear Theory	4043
REACTOR TECHNOLOGY	4048
Central Power Reactors	4048
Marine and Portable Power Reactors	4057
Rocket and Space Reactors	4057
Process Heat and Desalination Reactors	4060
Research and Test Reactors and Critical Assemblies	4061
Production Reactors	4062
Reactor Theory, Components, Fuels, and Accessories	4062
GENERAL	4068
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-12
SUBJECT INDEX	INDEX-75
REPORT NUMBER INDEX	INDEX-184

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 28, 1966.

Volume 22, Number 18 September 30, 1968

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 37709, 37835, 37855, 38012, 38075, 38076, 38235, 38270, 38287, 38457, 39543, 39552, 39638, and 39671.

37636 (AAEC/M-83) METHODS FOR THE EXAMINATION OF EXHAUSTED ION EXCHANGE RESINS FROM THE REACTOR HIFAR. Ryan, H. F. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1968. 16p. Dep.

Analytical methods for examination of exhausted mixed-bed ion-exchange resins used to purify the primary circuit of the reactor HIFAR are listed and discussed. Development work on methods for separating the mixed bed into its anion and cation resin components using chloroform/acetone mixtures is reported in detail, together with methods for determining strong and weak base capacities of the anion resin. (auth)

37637 (AD-664347) PHOTOACTIVATION OF CERIUM, NEODYMIUM, SAMARIUM, AND GADOLINIUM. Report No. Scientific-3. Kegel, Gunter H. R. (Controls for Radiation, Inc., Cambridge, Mass.). Oct. 1967. Contract AF19(628)-5980. 44p. (AFCRL-67-0595). CFSTI.

Reference data for the activation determination of cerium, neodymium, samarium, and gadolinium are presented. Samples of approximately 1 gram each of cerium oxide, neodymium oxide, samarium oxide, and gadolinium oxide, were irradiated on the AFCRL linear accelerator with a bremsstrahlung beam. Conditions of irradiation are reported. Induced activities were measured with a gamma spectrometer, using a lithium drifted germanium detector. Results of these measurements are discussed and minor revisions in the decay schemes of ^{135}Ce, ^{141}Nd, ^{149}Nd, and ^{159}Gd are proposed. The standard analytical sensitivity for cerium, neodymium, samarium, and gadolinium determinations is defined as the mass of the element which yields an activity of 1000 disintegrations per minute. These sensitivities vary from 0.2 mg (neodymium to 30 mg cerium). (USGRDR)

37638 (ANL-Trans-610) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, CENTER FOR NUCLEAR STUDIES AT FONTENAY-AUX-ROSES, DIRECTION OF NUCLEAR MATERIALS AND FUELS, DECEMBER 1966-MAY 1967. Translation of Sections 1 and 4, pp 5-56; 79-86 of report CEA-N-856. 63p. Dep. CFSTI.

For abstracts of individual sections see: 37639 and 37704.

37639 (ANL-Trans-610, pp 1-56) [CHEMICAL ANALYSIS]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 1, pp 5-56 of report CEA-N-856.

The development of analyses connected with Pu are outlined. These include the determination of nitrogen in Pu, on-line analysis of nitrates in Pu solutions, separation of Pu for its determination in solutions from the dissolution of irradiated fuels, chromatography and electromigration of transuranium elements, mass spectrometry of fuel elements to determine the isotopic composition of Pu and of U, determination of carbon traces, and recovery of Pu in a small installation utilizing classical methods of treatment. The efficiency of coulometric determination of Pu in reconstituted fuels with Pu contents from 0.15 to 0.3% was studied. A maximum systematic deviation of 0.4% was obtained. A second α, β, γ installation for the analysis of irradiated fuel elements was constructed and its design is briefly outlined. Developments made in chemical and electrochemical analytical techniques are reported. The most significant are the polarographic determination of Sn in U-Zr plates, determination of Au or Fe by controlled potential coulometry, and improvement of the polarographic method for the determination of the O/U ratio in uranium oxides. The characteristics of a pulse polarograph were studied and the results show that in the determination of Ni, the presence of U interferes with the determination by reducing the height of the peak corresponding to Ni. Developments and improvements made in optical emission, atomic absorption, and x-ray fluorescence spectrometry are outlined. The techniques developed and their efficiency in the determination of oxygen in Mg, the analysis of $Fe_2O_3-Cr_2O_3$ fritted compounds, and the chromatography of organometallic compounds are described. The classical techniques used for determination of B in metal were applied to the analysis of U-B, U-Mo-B, and Mg-Al-B alloys. Classical techniques were also used for determination of P in phosphides and phosphocarbides in the presence of U, the determination of S in uranium sulfides, determination of sulfur traces in U, determination of Si in U, and the determination of Mn in U. The use of organic solvents in the determination of Th in U, the determination of Al in U and the effect of Th and Zr on this determination, and for the separation of Zr and U in hydrochloric medium was discussed. The results obtained in the determination of Ca and Cu in Be by atomic absorption spectrophotometry were satisfactory. The principal aspects in the analytical program for the control of nuclear materials were the adaptation of methods already used in the laboratory for analysis of uraniferous concentrates and analysis of uranium tetrafluoride, comparison of the methods for determination of U in uraniferous concentrates, and development and improvement of spectrophotometric methods and atomic absorption spectrophotometry. These include the determination of Ru in bathophenanthroline, determination of Th in thoria, determination of Ca in Mg, and determination of Zn in U. The arc fractionated distillation method for analysis of U and its alloys was studied to determine the effect of the chemical composition of the matrix as a function of the nature of the carrier and to improve the reproducibility of the method. The use of uranium-base standards can, in the case of alloys of the MASURCA type, lead to results erroneous by a factor of 3 to 5. The activities of the Cadarache Analytical Laboratory are summarized. (J.S.R.)

37640 (ANL-Trans-628, pp 2-50) [PREPARATION AND STUDY OF ACTINIDE ELEMENTS]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 10, pp 299-349 of report CEA-N-856.

For analytical separation of Np from concentrated U solutions, inverse-phase chromatography with trilaurylamine (TLA) in reducing medium (Fe^{2+}, Pu^{3+}, Np^{4+}, U^{4+}) was investigated. The separation efficiency was determined on synthetic solutions and it was verified that the Np contained in a volume $V_f \leq 10$ ml of fixation solution is quantitatively extracted. The separation coefficients were determined for lanthanides and Am between the organic phase containing TLA and 40% HNO_3 in a mixture of 50% dodecane and 50% chlorobenzene and the aqueous phase with variable composition. The results show that it is possible to separate Am from the majority of lanthanides with high separation factors. The separation factors obtained for lanthanides and Am using tributyl phosphate, trioctylphosphine oxide, methyl dibutyl phosphonate, tributylphosphine, and diphosphonates were determined. The results are tabulated. The processing of irradiated Pu and the dissolution of Pu-Al fuel elements was studied using two modes of dissolution: mixed dissolution and acid dissolution. In the first method the Al from the cladding and the alloy is dissolved in alkaline medium and then after evacuation of the basic solution, the Pu and the major part of the irradiation products are dissolved in nitric acid. In the acid

dissolution, the Al, Pu, and irradiation products are dissolved in a single operation. The results obtained from both dissolution methods are reported and discussed. The mixed dissolution yields in a small volume the irradiation products free from Al and well decontaminated from Cs. The acid dissolution gives inverse results, but its use is much simpler. The Pu cycle in the processing of irradiated Pu, in which the Koehly procedure of the trilaurylamine separation is used, is described. The initial solutions are those from dissolution of irradiated Pu–Al. Preparation of the solutions and operation of the mixer-decanter batteries are described. Results obtained are reported in graphic and tabular form. The methods used for determination of Pu, Ru, rare earths, Zr, free acid, and Al in solutions from the processing of irradiated Pu are described. The fabrication of Np and Am irradiation targets is reported. Examples are given of the use of actinides in radioelectrochemical conversion systems. (J.S.R.)

37641 (BAW-3809-2) POST-IRRADIATION EXAMINATION OF THORIA–URANIA FUEL RODS. Quarterly Progress Report No. 2, September–November 1967. Bishop, W. N.; Marsh, S. F. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). June 1968. Contracts AT(30-1)-3809; 59-3103. 23p. Dep. CFSTI.

The fuel rods for this program were removed from the fuel elements at Battelle Memorial Institute and transported to the Babcock & Wilcox Nuclear Development Center. Most of the rods were gamma scanned. A sequential chemical separation procedure for uranium, plutonium, americium–curium, cesium, neodymium, promethium, and samarium was refined and is considered ready for use on thoria–urania fuels. This procedure uses four columns; two extraction chromatography columns and two inorganic ion exchange columns, for separation of the elements. Two separation procedures for neptunium were evaluated and a solvent extraction procedure was selected for this program. (auth)

37642 (BNWL-SA-1776) MULTIELEMENT ANALYSIS OF SEAWATER, MARINE ORGANISMS AND SEDIMENTS BY NEUTRON ACTIVATION WITHOUT CHEMICAL SEPARATIONS. Robertson, D. E.; Rancitelli, L. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 15, 1968. Contract AT(45-1)-1830. 74p. (CONF-680618-1). Dep. CFSTI.

From International Symposium on the Applications of Neutron Activation Analysis in Oceanography, Brussels, Belgium.

Neutron activation and direct counting techniques were employed to measure the concentrations of numerous trace elements in seawater, marine organisms, and pelagic sediments. Neutron-activated samples were counted directly on either a multidimensional gamma spectrometer or a large-volume, high-resolution Ge(Li) diode spectrometer after optimized decay periods. Using these direct counting techniques concentrations of the trace elements Sr, Cs, U, Co, Sb, Zn, Fe, and Sc were measured in seawater samples and their distribution over a wide geographical area of the Pacific and Atlantic Oceans was determined. The concentrations of Zn, Co, Ag, Cs, Sb, and Sc were measured in a large number of surface, midwater and benthic marine organisms from various trophic levels. The additional elements Na, K, Rb, Br, Fe, Se, and Hg were also measured in silver salmon and Alaskan king salmon tissue samples. The elements Mn, Fe, Cu, Zn, Co, La, Sc, and Sb were measured in pelagic sediments and in manganese nodules by directly counting neutron-activated samples on a multidimensional gamma spectrometer. By using a Ge(Li) diode detector and properly selected irradiation and decay periods, it is also possible to measure the additional elements, Al, V, Dy, Ba, Cr, Ce, Sm, Yb, Lu, Hf, and Th in sediment samples by direct counting. These direct counting methods greatly simplified the multielement analysis of samples from the marine environment by eliminating the uncertainties associated with many complex chemical preconcentration and separation procedures. Also, the inherent risk of contamination of the samples during such procedures is eliminated. The behavior of several artificial radioelements entering the marine environment as fallout, relative to their stable element counterparts, was determined and the importance of chemical of physical form on the behavior of an element in the ocean is emphasized. Methods for extracting trace radionuclides from large volumes of seawater to depths as great as 1600 meters are described. (auth)

37643 (CEA-R-3337) ANALYSE ISOTOPIQUE DE L'HEXAFLUORURE D'URANIUM FORTEMENT ENRICHI EN U 235. (Isotopic Analysis of UF_6 Hexafluoride Highly Enriched in ^{235}U). Chaussy, Louis; Boyer, Robert (Commissariat a l'Energie Atomique, Pierrelatte (France)). Mar. 1968. 51p. (In French). Dep.

Isotopic analysis of uranium in the form of the hexafluoride by mass spectrometry gives gross results that are not very accurate. Using a linear interpolation method applied to two standards it is possible to correct for this inaccuracy as long as the isotopic concentrations are less than about 10% in ^{235}U. Above this level, the interpolation formula overestimates the results, especially if the enrichment of the analyzed samples is higher than 1.3 with respect to the standards. A formula is proposed for correcting the interpolation equation and for extending its field of application to high enrichment values and to high concentrations. By using this correction the results have an accuracy that depends on that of the standards, taking into account the dispersion in the measurements. (auth)

37644 (CEA-R-3410) CONTRIBUTION A L'ANALYSE ISOTOPIQUE DE L'AZOTE PAR SPECTROMETRIE OPTIQUE. (Contribution to the Isotopic Analysis of Nitrogen Using Optical Spectrometry). Leicknam, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 49p. (In French). Dep.

The possibility of analyzing a gaseous mixture by emission spectrometry that is poor in ^{15}N (isotopic abundance less than 2%) was investigated. The method of isotopic analysis proposed only requires a spectrometer of average resolving power; it is even possible to use a spectrograph with a slit replacing the photographic plate, and a photomultiplier; this transformation is very simple to carry out and the signals from the detector can then be received by a recorder. Under these conditions a measurement takes only from three to ten minutes, according to the accuracy required. The light sources are made up of electrode-less discharge lamps, excited by high frequency; the filling conditions are such that the lamps may be prepared in a few minutes, the impurities being sufficiently eliminated for the measurements not to be affected. The choice of the analytical band couple depends on the relative position of the isotopic bands and on the possible presence of traces of these impurities: amongst the transitions in the system $C(^3\pi_u) \rightleftharpoons B(^3\pi_g)$, it is the $2 \rightarrow 0$ transition that has the most favorable position for this isotopic analysis. The method was applied to samples of varying origins (ammonium salts, fertilizer and plants): the isotopic contents were determined with an accuracy of 3% in the neighborhood of the natural abundance, and of 1% when the sample contained about 1.5 atoms of ^{15}N for 100 atoms of ^{14}N. The accuracy is therefore quite sufficient for most of the biological research using the mass 15 as tracer. (auth)

37645 (CEA-R-3452) PROGRAMMER FOR AUTOMATIC GAMMA SPECTROMETRY. Romanetti, Robert (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Apr. 1968. 44p. (In French). Dep.

Thesis. Submitted to Univ., Aix-Marseille, France.

With this apparatus, which is constructed of logical integrated circuits, it is possible both to synchronize an automatic gamma spectrometry assembly and to record the spectra on punched cards. An IBM terminal will make it possible with the help of analysis by the least squares method and by a direct dialogue with an IBM 360 computer to obtain analytical results almost instantaneously. (auth)

37646 (CEA-R-3457) CONTRIBUTION A L'ANALYSE ISOTOPIQUE DE ROUTINE DE L'URANIUM 235 PAR SPECTROMETRIE D'EMISSION. I. INTERFEROMETRIE AVEC DES LAMPES A DECHARGE SANS ELECTRODE. (Routine Isotopic Analysis of ^{235}U by Emission Spectrometry. I. Interferometry Using Electrodeless Discharge Lamps). Capitini, Robert; Ceccaldi, Maurice; Leicknam, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1968. 67p. (In French). Dep.

A "HYPEAC" interferometric apparatus was used for routine determination of ^{235}U. In order to facilitate the examination of nonmetallic samples and to reduce the time required for analysis it was necessary to replace the hollow-cathode light sources usually used by electrodeless discharge lamps. The preparation outside the apparatus of such lamps containing uranium tetrachloride is described; the process is simple and rapid: about ninety minutes for each, and several lamps can be built simultaneously, thus reducing still further the total time required for each analysis. The amount of sample required is a few milligrams. In order to counteract any spontaneous optical disadjustment, which could prevent the application of the usual isotopic abundance method, it is necessary to compare the sample spectra with those of standards. All the spectra are recorded successively and alternately. A series of examples of determinations involving over 150 measurements is presented and discussed. For samples with abundances similar to that of natural uranium and up to 5% of the 235 isotope, the reproducibility is of the order of 2%. The relative accuracy is ±2 to 3%. For samples enriched in ^{235}U (5 to 93%) the relative accuracy can attain ±0.5%. (auth)

37647 (EUR-3949) ISOTOPIC ANALYSIS OF IRRADIATED FUEL AND TRANSPLUTONIUM ELEMENTS. 1. OBJECTIVES

AND METHODS. Geerlings, M. W.; Koch, L. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Apr. 25, 1968. 25p. Dep.

The activity of the European Institute for Transuranium Elements in the analysis of irradiated fuel and transplutonium elements is described. The objectives and the usefulness of such analyses and selected experimental methods are outlined. The analyses form a part of the post-irradiation examination of irradiated reactor fuel and fuel elements, with the emphasis on plutonium-containing materials. Their major purpose is the determination of precise values, and of their spatial variations, of burnup and conversion of fissile and fertile nuclides. They also concern the formation of isotopes of transplutonium elements. (auth)

37648 (NP-17520) UTILISATION DE LA CHROMATOGRAPHIE POUR LE DOSAGE DES PRODUITS HALOGENES. (Use of Chromatography for Analysis of Halogen Products). Delvalle, P[aulette] (Commissariat a l'Energie Atomique, [Paris] France). May 1961. 2p. (In French). Dep.

Values for the time of relative retention of various halogen products were compared with those reported in a previous study. The value determined for UF_6 is 4.1 as compared with the previously reported 5.15. It was found that the time of retention is a function of the quantity of material introduced. (J.G.B.)

37649 (NYO-3838-1) ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY. Summary of Progress, 1967-1968. Mangelsdorf, Paul Jr.; Wilson, Roger S. (Woods Hole Oceanographic Institution, Mass.). June 1968. Contract AT(30-1)-3838. 8p. Dep. CFSTI.

Initial work on the high-pressure difference chromatography system showed that the expected improvement in resolution and speed of elution, compared with the previous low-pressure system, was obtained. Experiments using "spiked" seawater were undertaken, and it was found that the system was capable of detecting changes in the K/Cl ratio of a seawater of less than 0.1%. The Ca/Cl ratio could be measured to about 0.25%. Using difference chromatography, a single determination of the K/Cl and Ca/Cl ratios in an unknown sample can be completed in 15 minutes. The K/Cl and Ca/Cl ratios of the standard were determined by comparing the standard to a series of carefully prepared artificial seawaters in which these ratios were known precisely. The values thus obtained are 0.02034 and 0.02068, respectively. Determinations on water samples collected off Puerto Rico indicated the layer above the thermocline has a K/Cl ratio some 0.2% higher than the deeper water. Although this effect is small, it was possible to show that it exists in each of the six water columns sampled. Extensive replication of analyses was used to improve the reliability of the results. (J.G.B.)

37650 (ORNL-TM-2238) PROTON REACTION ANALYSIS FOR LITHIUM AND FLUORINE IN GRAPHITE, USING A SLIT SCANNING TECHNIQUE. Macklin, R. L.; Gibbons, J. H.; Handley, T. H. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

Protons from the ORNL 3-MV Van de Graaff accelerator were brought to a line focus and collimated through slits of either 0.025 or 0.0075 cm. Cross-sectional cuts of graphite samples were moved across the beam to study the distribution of Li and F with depth by measuring the yields of neutrons and of gamma rays from the reactions $^{7}Li(p,n)$ and $^{19}F(p,\alpha\gamma)$. A graphite sample exposed to molten fluorides in a loop experiment at the Oak Ridge Research Reactor showed about 20 and 100 ppM (by weight) Li and F respectively, 2 mm below the exposed surface. The observed ratio of Li to F was close to that characteristic of the molten salt down to 3 mm below the exposed surface. (auth)

37651 (SC-TM-68-234) STUDY OF THE PARAMETERS USED IN THE DETERMINATION OF BERYLLIUM IN AIR SAMPLES USING THE EMISSION SPECTROGRAPH. Gross, Ednarae (Sandia Corp., Albuquerque, N. Mex.). May 1968. Contract AT(29-1)-789. 13p. Dep. CFSTI.

Some changes in the parameters used in determination of beryllium in air samples using the emission spectrograph improved reproducibility and reduced error. The parameters studied were slit width, electrode waterproofing, burning rate of Be, and the slit height. (auth)

37652 (UCRL-18140) PROCEEDINGS OF THE 13TH ANNUAL BIOASSAY AND ANALYTICAL CHEMISTRY MEETING HELD AT LAWRENCE RADIATION LABORATORY, OCTOBER 12 AND 13, 1967. Low-Beer, Anne deG. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 293p. (CONF-671048). Dep. CFSTI.

Twenty-two papers are included under the following headings: procedures and analytical methods, distribution patterns of radioactive nuclides, chemical toxicology, and legalistic aspects of the bioassay program. Separate abstracts were prepared for 13 of the papers. One paper was previously abstracted for NSA. For abstract numbers of individual papers see CONF-671048 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 37653-37656, 37877, 38198, 38199, 38264-38268, and 38428.

37653 (UCRL-18140, pp 13-36) LABORATORY BLANK EXPERIENCE IN LONG-LIVED FISSION PRODUCTS. Wessman, R.; Szidon, R.; Major, W.; Melgard, R.; Leventhal, L. (Tracerlab, Richmond, Calif.).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

The analytical program under way at Tracerlab is periodically tested for radioactive blanks. The potential blank due to the chemistry and counting is discussed. Each contributor such as reagents carrier, and planchets is examined. The potential for contribution by the laboratory environment, equipment, and glassware is determined. Blank procedures are carried through complete sample dissolution, separation, and purification. Since the blanks follow closely the route of actual samples through the chemistry and counting laboratories, they are specific for the isotope of interest. Wherever possible, the source and the activity found are identified so that steps to remove the undesired activity are effective. The effect of the counting instruments background relative to the limits of detection is assessed. Laboratory blank data for ^{90}Sr, ^{137}Cs, ^{144}Ce, and ^{147}Pm taken during the past ten years are presented and discussed. The methods and techniques developed to reduce the individual blanks are described. The total laboratory blank was reduced to 0.2 to 0.3 cpm, of which most is due to the planchet assembly. This experience resulted in a mode of laboratory operation that leads to a minimum and consistent blank. These precautions are discussed and recommendations for further potential reduction proposed. (auth)

37654 (UCRL-18140, pp 57-69) RADIOCHEMICAL DETERMINATION OF ^{35}S. Taylor, R. W. (E. I. du Pont de Nemours and Co., Aiken, S. C.). (DP-MS-67-40).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

A rapid, accurate method was developed to determine ^{35}S in Savannah River Plant waste streams. ^{35}S is partially purified by extracting other radionuclides into triisooctylamine from 2N HCl. ^{35}S is further purified by precipitating $BaSO_4$ from the aqueous phase, dissolving this precipitate in hot alkaline EDTA, and reprecipitating $BaSO_4$. Liquid scintillation counting is used for radioassay. A gelling agent suspends the $BaSO_4$ precipitate in the scintillation solution. Counting efficiency of ^{35}S as $BaSO_4$ is 58%. The chemical recovery of ^{35}S from aqueous samples is about 90%; therefore, the overall efficiency of the procedure is about 52%. Decontamination factors for radionuclides likely to occur in plant waste streams are at least 10^3. (auth)

37655 (UCRL-18140, pp 91-9) RAPID DETERMINATION OF THORIUM AIR FILTERS BY NEUTRON-ACTIVATION ANALYSIS. Nass, Harold W.; Kramer, Henry H. (Union Carbide Corp., Tuxedo, N. Y.).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

A rapid neutron-activation analysis method was developed to determine concentrations of ^{232}Th in air filters down to 5 micrograms, a level well below that necessary for monitoring occupational exposure to thorium. (auth)

37656 (UCRL-18140, pp 101-2) RECENT DEVELOPMENTS IN THE SEQUENTIAL DETERMINATION OF URANIUM AND TRANSURANIUM ELEMENTS USING BARIUM SULFATE. Sill, Claude W. (Atomic Energy Commission, Idaho Falls, Idaho).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Precipitation of large ter- and quadrivalent elements by barium sulfate was extended to the separation of uranium and the transuranium elements both from other elements and from each other. From 25 ml of solution containing sulfuric acid, potassium sulfate, and hydrogen peroxide, carrier-free quantities of all elements from lead through at least californium, except astatine, radon, francium, and uranium, are precipitated to approximately 99% by only 5 mg of barium ion. Uranium can also be included in the list of elements precipitated by reducing it to the quadrivalent state with titanium trichloride either before or after precipitation of barium sulfate. Like uranium, the transuranium elements through americium can be prevented from precipitating by oxidizing them to the hexavalent state in which the oxygenated cation is too large to fit into the barium sulfate lattice. Also, because of the marked differences in their oxidation potentials, uranium and the first four transuranium elements can be separated from other nonoxidizable

ions and from each other by proper control of the oxidizing agent used. The precipitate can be mounted on a 2-inch stainless steel plate by centrifugation and counted directly in an alpha counter with less than about 10% loss of counting efficiency due to the solid absorber present. The barium sulfate can be dissolved in water after evaporation with hydriodic and perchloric acids to reduce and volatilize the sulfate ion. The radionuclides present in the barium sulfate can then be electrodeposited from the resulting aqueous solution and each specific isotope present identified by alpha spectrometry. This procedure permits not only traditionally difficult separations such as americium from curium or the determination of extremely minute quantities of one transuranium element in the presence of large quantities of another to be made simply and quickly, but mixtures of uranium and the first four transuranium elements can be separated sequentially from each other and identified on the same sample in a single procedure. Furthermore, since virtually every alpha-emitting nuclide known can be precipitated on barium sulfate under the proper conditions, a chemical separation can be employed to eliminate the absorbing material from large samples without losing the concept of a true gross alpha procedure. (auth)

37657 (UCRL-50441) EVALUATION OF THE PROMPT SAMPLE SYSTEMS USED FOR THE ANACOSTIA AND KENNEBEC EXPERIMENTS. Brady, Jack D. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 15, 1968. 14p. Dep. CFSTI.

As a part of the Plowshare scientific program, two low yield thermonuclear devices (Anacostia and Kennebec) were fired underground at the Nevada Test Site in November 1962 and June 1963. These experiments were designed to produce very heavy elements by multiple neutron capture in a ^{238}U target. Rapid recovery of the resultant products was attempted using the force of the explosion to blow debris up a 10-in. diam, liquid filled pipe to the ground surface and collect the debris in retention tanks. Small samples recovered from the retention tanks immediately after the explosions were poorer in transuranium elements than were the core samples obtained later from postshot drilling. Radiochemical analyses of additional samples recovered from the collection tanks and piping of each prompt sampling system show that the Anacostia system collected between 10 and 40 kg of solids with a specific Pu content (dis/min-g of dry rock) equivalent to good puddle glass samples. The Kennebec system collected 360 kg of chemically fractionated rock with a specific Pu content nearly equal to puddle glass samples. (auth)

37658 DERIVATIVE NEUTRON ACTIVATION AND SPECTROPHOTOMETRIC ANALYSIS OF p-BROMOBENZOYLTRIFLUOROACETONE CHELATES OF Fe(II) AND Fe(III). Chan Cheng, Francisco College Park, Md., Univ. of Maryland, 1967. 120p. Thesis.

A new compound, 4,4,4-trifluoro-1-(4′-bromophenyl)-1,3-butanedione, (parabromobenzoyltrifluoroacetone, BBTFA), was synthesized as a multi-purpose reagent useful in chelate extraction, absorption spectrophotometry, paper chromatography, neutron activation analysis and x-ray fluorescence spectroscopy. The melting point of BBTFA was 56 to 57°C. Satisfactory chelate extraction techniques were developed for the separation of the BBTFA chelates of ferrous and ferric iron. The BBTFA chelates of Fe(II) and Fe(III) were successfully separated from synthetic mixtures of Fe(II) and Fe(III) at their respective optimum pH values and determined spectrophotometrically with a precision of ~±5% in the concentration range 0.03 to 0.20 μmole/ml(~2.0 to ~11.0 μg/ml of Fe). The ratios of BBTFA-to-iron of the chelates of Fe(II) and Fe(III) determined by Job's method, were 2:1 and 3:1, respectively. The bromine-to-iron ratio of Fe(III)-BBTFA chelate was established by x-ray fluorescence spectroscopy, elementary analysis, and neutron activation. The lower limit of Fe(III) extraction determined by ^{59}Fe tracer studies was at least 0.004 μg/ml. Satisfactory paper chromatographic techniques and solvent systems were developed and established for the separation of Fe(III)–BBTFA chelate. Derivative neutron activation chromatography was applied to the determination of the Fe(III)–BBTFA chelate. The chromatograms containing the isolated and purified Fe(III)–BBTFA chelates were activated in the University of Maryland Reactor with a thermal neutron flux of 10^{11} neutrons/(cm^2)(sec) for 8 to 12 hr. The activated chromatograms were stored for at least 20 hr to allow the short-lived isotopes to decay. By comparing the induced radioactivity of ^{82}Br of an unknown sample with that of a known sample, the quantity of iron was determined. Derivative neutron activation chromatography of Fe(III)–BBTFA chelate was successful in the range of 0.002 to 0.08 μmole (~0.1 to ~5.0 μg of Fe). The Fe(II)–BBTFA chelate was oxidized to Fe(III) prior to chromatography and activation analysis and determined as Fe(III)–BBTFA chelate. The spectrophotometric method and derivative neutron activation chromatography were applied successfully to total iron determination of silicate samples of known content supplied by the United States Geological Survey. The Fe(III)–BBTFA chelate can be determined spectrophotometrically even in the presence of large amounts of Al(III) with a precision of ~±5% over the range of 0.05 to 0.25 μmole/ml (~3.0 to ~15.0 μg/ml of Fe). However, Al(III) in large amounts, interfered with the derivative neutron activation of Fe(III)–BBTFA chelate. In the absence of Al(III) interference, derivative neutron activation chromatography of Fe(III) was also successful with a precision of ~±5% over a range of 0.03 to 0.08 μmole (~2.0 to ~5.0 μg). Difficulty was encountered in the determination separately, of Fe(II) and Fe(III) in the silicate samples because of the instability of Fe(II) toward oxidation. (Disser. Abstr.)

37659 SCINTILLATION COUNTING OF THE NINHYDRIN-AMINO ACID-^{14}C REACTION PRODUCTS FROM AN AUTOMATIC AMINO ACID ANALYZER. Olson, Alfred C.; White, Lawrence M.; Noma, Amy T. (Agricultural Research Service, Albany, Calif.). Anal. Biochem., 24: 120-7(July 1968).

A method is described in which the effluents of an amino acid analyzer which contain ^{14}C-labeled amino acids are collected and aliquots of the ninhydrin colored solution counted in a scintillation counter. The colored ninhydrin reaction product does not quench the counting when as much as 0.4 ml containing 0.2 μmole amino acids is added to 20 ml of counting solution. Since there is loss of the carboxyl group in the reaction, only those amino acids with ^{14}C in positions other than the carboxyl will be detected by this method. Analysis of commercially available uniformly labeled amino acids from protein hydrolyzates by this procedure suggests that each carbon in the amino acids may not have the same specific activity and that the carboxyl carbon may have a disproportionate share of the activity. The technique was applied to studies of proline metabolism. (auth)

37660 HIGH-RESOLUTION METHOD FOR SLICING AND COUNTING RADIOACTIVITY IN POLYACRYLAMIDE GELS. Gray, Robert H.; Steffensen, Dale M. (Univ. of Illinois, Urbana). Anal. Biochem., 24: 44-53(July 1968).

A new method is described for slicing polyacrylamide gels and counting radioactivity in macromolecules separated by disc electrophoresis. Polyacrylamide gels are dehydrated and sectioned uniformly with a rotary microtome into slice thicknesses of 250, 125, 62.5, or less than 50 μ. The gel slices are solubilized in hydrogen peroxide and counted in Bray solution. The counting efficiency for ^{14}C and ^{35}S is about 90% and about 33% for ^{3}H. The method is also applicable for analyses of double-labeled compounds in polyacrylamide gels. (auth)

37661 RAPID SEPARATION OF STRONTIUM AND BARIUM. Taylor, R. W.; Boulogne, A. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 15: 25-9(July 1968).

An analytical procedure is described for the rapid determination of $^{89,90}Sr$ in the presence of $^{140}Ba-^{140}La$ and other fission products in waste water from reactor isolation basins, when the ^{140}Ba concentration is >25% of the $^{89,90}Sr$ concentration. The method combines a rapid inorganic ion exchange separation of barium from strontium, with precipitation of $Sr(NO_3)_2$ from fuming nitric acid, to give a 4-hr method suitable for prerelease analysis of waste water. Decontamination factors for the common fission products are $>10^3$. The recovery of added strontium is 85%, with a relative standard deviation of ±7% at the 90% confidence level. (auth) (UK)

37662 ATOMIC ABSORPTION SPECTROSCOPY WITH HIGH TEMPERATURE FLAMES. Willis, J. B. (Iowa State Univ., Ames). Appl. Opt., 7: 1295-1304(July 1968).

The history of the development of high temperature flames for the atomic absorption measurement of metals forming refractory oxides is outlined. The principles governing the design of premix burners for such flames, and the relative merits of different types of nebulizer burner systems are described. After a brief account of the structure and emission characteristics of the premixed oxygen–acetylene and nitrous oxide–acetylene flames, the scope and limitations of the latter flame in chemical analysis are discussed. (auth)

37663 ATOMIC EMISSION CHARACTERISTICS OF A PREMIXED ACETYLENE–NITROUS OXIDE, TOTAL CONSUMPTION FLAME. Mossotti, Victor G.; Duggan, Marjorie (Univ. of Illinois, Urbana). Appl. Opt., 7: 1325-30(July 1968).

The construction and performance of a highly efficient total consumption burner that produces a nonturbulent acetylene–nitrous oxide flame from premixed gases are reported. The eighteen flame emission detection limits tabulated for a select group of elements compare favorably with the best values heretofore reported in the literature, and the apparent freedom of alkaline earth emission from phosphate interference indicates the total consumption flame here described to be less subject to chemical

interference than is the conventional diffusion flame. The relatively low cost burner that has been developed is convenient to operate and can be quickly assembled from commercially available components. (auth)

37664 APPLICATION OF SEPARATED FLAMES IN ANALYTICAL FLAME SPECTROSCOPY. Kirkbright, G. F.; West, T. S. (Imperial Coll. of Science and Tech., London). Appl. Opt., 7: 1305-16(July 1968).

The separation of the zones of air–acetylene and nitrous oxide–acetylene flames and some applications of these flames in analytical flame spectroscopy are described. (J.G.B.)

37665 STANDARD PREPARING PROBLEMS CONCERNING THE DETERMINATION OF RESORPTION OF ^{131}I LABELLED FATS IN BLOOD SAMPLES. Bosnjakovic, V.; Novakovic, R. (Univ., Belgrade). Radiobiol.-Radiother., 8: 575-8(1967).

The determination of the resorption of labeled fats in blood samples requires the use of a well-type scintillation detector. However, it is difficult to prepare homogenously dilute reference standard solutions of the test dose of labeled fat for counting in this type of detector. Therefore, for determination of the percentage of resorbed radioactivity in blood, a method using vivo and well scintillation detectors and a water $Na^{131}I$ standard solution for determining the sensitivity ratio of these two detectors is presented. (auth)

37666 ISOLATION AND DETECTION OF ATOMIC RESONANCE LINES. Sullivan, J. V.; Walsh, A. (Commonwealth Scientific and Industrial Research Organization, Melbourne). Appl. Opt., 7: 1271-80(July 1968).

Since the spectrum of the resonance radiation from an atomic vapor consists only of those spectral lines that are absorbed by the vapor, resonance lamps can serve as monochromators for isolating these lines. The atomic vapor is produced by cathodic sputtering in a rare gas discharge or, in the case of elements with high vapor pressure at low temperatures, by indirect electrical heating of the appropriate metal. Alternatively, the resonance lines of an element can be isolated by allowing the spectrum of the element emitted by a dc operated atomic spectral lamp to pass through a pulsating cloud of atomic vapor of the same element produced by sputtering in a modulated discharge. The resonance lines are selectively modulated and produce a signal at the output of an ac detection system. Other lines in the spectrum produce no output signal since they are not absorbed by passage through the atomic vapor and are therefore not modulated. Atomic absorption spectrophotometers incorporating these two techniques for the isolation of resonance lines were constructed and their performance studied. (auth)

37667 INVESTIGATION OF DECOMPOSITION PRODUCTS OF ORGANIC REACTOR COOLANTS BY MEANS OF GAS CHROMATOGRAPHY. Lukac, S. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 209-15(July 1968). (In Czech).

A review is presented on the use of gas chromatography for the analysis of polyphenyl organic nuclear coolants. The application of the chromatographic columns containing organic as well as inorganic stationary phases, is discussed. These two types of chromatographic phases were compared from the point of view of their resolution powers within the studied range of high temperatures. The most convenient organic stationary phase was found to be silicon fats, while alkali chlorides provided the best results as inorganic stationary phase. (auth)

37668 ENERGY DISPERSION X-RAY ANALYSIS USING RADIOACTIVE SOURCES. Campbell, William J. (Bureau of Mines, College Park, Md.). pp 36-54 of X-Ray and Electron Methods of Analysis. van Olphen, H.; Parrish, William (eds.). New York, Plenum Press, 1968.

From 8th Eastern Analytical Symposium, New York. See CONF-661136-(Vol.1).

The advantages of radioisotope sources coupled with nondispersive techniques over conventional dispersive systems are outlined. There are three types of radioisotope sources—α-, β-, and γ-emitters. Typical α- and β-emitters are ^{210}Po and $^{3}H/Zr$, respectively. Generally beta emitters are used to generate primary x rays which, in turn, excite secondary x rays in the sample. Gamma sources may be either monochromatic, e.g., ^{55}Fe (Mn K) or high-energy γ-emitters used in conjunction with a secondary emitter $^{241}Am-Cs$. In nondispersive analysis, energy discrimination is achieved by selective filtration, balanced filters, differential absorption in the detector, and electronic pulse amplitude discrimination. All of these methods may be used individually or in various combinations. Applications of these portable analyzers include prospecting and mining operations, monitoring of metallurgical processes, and automatic sorting of mail. (auth)

37669 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM AND MANGANESE IN Mg–Zr AND Mg–Zr–Mn ALLOYS. Pouzaud, G. Mem. Sci. Rev. Met., 65: 59-60(Jan. 1968). (In French).

The sample to be analyzed is attacked by a cold solution of hydrochloric acid. Under these conditions very fine insoluble particles remain in suspension, and are filtered off. The Zr in the filtrate is determined by a colorimetric method after formation of a red complex with Alizarine S. The insoluble fraction is then dissolved and the Zr is determined colorimetrically. The Mn is determined colorimetrically after oxidation of the Mn ion by potassium periodate in a mixture of nitric and phosphoric acid. The precision of the determination of Zr is ±1.5% and that of Mn is ±1%. (J.S.R.)

37670 X-RAY AND ELECTRON METHODS OF ANALYSIS. Selected Papers from the 8th Eastern Analytical Symposium, New York, November 16–18, 1966. van Olphen, H.; Parrish, William (eds.). Progress in Analytical Chemistry. Volume 1. New York, Plenum Press, 1968. 173p. (CONF-661136-(Vol.1)).

Papers on the following topics are included: x-ray diffractometry methods for complex powder patterns, quantitative electron microprobe analysis, determination of specific surfaces by small-angle x-ray-scattering methods, determination of particle-diameter distributions by small-angle x-ray scattering, small-angle x-ray scattering and low-energy electron diffraction studies of catalyst surfaces, and analysis of low-angle light scattering from simple mixtures. One paper was abstracted separately for inclusion in NSA. (J.G.B.)

For an abstract of the individual paper see: 37668.

37671 CONCENTRATIONS AND DISTRIBUTIONS OF SELECTED CHEMICAL ELEMENTS IN THE METALLIC, SULFIDE, AND PHOSPHIDE PHASES OF IRON METEORITES VIA NEUTRON ACTIVATION ANALYSIS. Linn, Thomas Arthur Jr. Tempe, Ariz., Arizona State Univ., 1968. 159p.

Thesis.

The behavior of selected chemical elements in the iron meteorites was investigated. A nondestructive method of activation analysis is applied to small samples of the metallic and major phases from iron meteorites. The concentrations of vanadium, manganese, cobalt, copper, and gold in the metal, sulfide, and phosphide phases of the iron meteorites were determined. Calculations were then made to obtain the distribution ratios between phases. The concentrations and distribution ratios are related to the structural classes, to nickel content, and to the Ga–Ge groupings of the meteorites studied. The concentration data provide more complete chemical characterization of these meteorites. The distribution ratios provide information about the geochemical behavior of these elements in the phases studied. The relationships observed are discussed in relation to meteorite structures, and to genetic classifications established by previous investigations of Ga–Ge ratios, and of certain noble metal concentrations. All the elements studied show properties related to structural classifications, relatively independent of genetic classes of the meteorites, with the possible exception of vanadium. (auth)

37672 THE USE OF N-BENZOYLPHENYLHYDROXYLAMINE FOR THE AMPEROMETRIC TITRATION OF NIOBIUM(V). Gallai, Z. A.; Sheina, N. M.; Nifontova, N. (Moscow State Univ.). Zh. Anal. Khim., 23: 942-4(June 1968). (In Russian).

A method was developed for the amperometric titration of niobium(V) with a N-benzoylphenylhydroxylamine solution in 10 N HCl using an impregnated graphite electrode. Large amounts of nickel, cobalt, zinc, aluminum, manganese(II), chromium(III), iron, zirconium, rhenium, and vanadium(V) did not interfere. (auth)

37673 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. PART 5. DETERMINATION OF MOLYBDENUM BY A THIOCYANATE METHOD USING PHOTOCHEMICAL REDUCTION. Nemodruk, A. A.; Bezrogova, E. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 884-8(June 1968). (In Russian).

The photochemical reduction of Mo(VI) to Mo(V) by ethanol was studied, and it was found that if the dissolved oxygen was removed by passing CO_2 through the solution containing 13 to 20% of ethanol and 4 to 9 N H_2SO_4 Mo(VI) is reduced quantitatively only to Mo(V) on irradiation of the solution with a PRK-7 lamp during 20 to 30 min. Accurate and readily reproducible results are obtained when the photochemical reduction of Mo(VI) to Mo(V) is followed by its determination by a thiocyanate method. (auth)

37674 L'ANALYSE PAR ACTIVATION. TRAITEMENT DES INFORMATIONS EN SPECTROMETRIE GAMMA APRES IRRADIATION AUX NEUTRONS. (Activation Analysis. Investigations in

Gamma Spectrometry After Neutron Irradiation). Perdijon, J. Collection de Monographies de Chimie. Paris, Masson et Cie, 1967. 163p. 68F.

The principles of activation analysis are discussed, including: basic theories; determination of the number of counts from the dose of the element; qualitative analysis; quantitative analysis; and method by removal (least squares). A table of isotopes and nuclear reactions used in neutron activation analysis is appended along with information on use of electrostatic accelerator as neutron generator, use of NaI(Tl) scintillator in gamma spectrometry, and experimental sensitivities obtained in neutron activation analysis and gamma spectrometry by means of an accelerator of 150 kV. (P.C.H.)

37675 ESCA STUDIES OF ATOMS AND MOLECULES. Nordberg, Ragnar. Abstracts of Uppsala Dissertations in Science, No. 118. Uppsala, Uppsala Univ., 1968. 12p.

Thesis.

Twelve published papers on electron spectroscopy for chemical analysis (ESCA) are summarized. The following topics are reviewed: an apparatus for the ESCA method; a new magnetic instrument for ESCA; computer investigations of a double-focusing spectrometer and comparisons with experimental results; revision of electron binding energies in light elements; an electron spectroscopic determination of the L_I energy in the elements sodium (Z = 11) to copper (Z = 29); energy determination of the N_{VI}, N_{VII}, and O_{III} levels in the elements of Hf (Z = 72) to Bi (Z = 83); electron spectroscopic determination of electron binding energies in plutonium; Auger spectra for elements of low atomic number; chemical shifts in Auger spectra; electron spectroscopy and chemical binding; molecular spectroscopy by means of ESCA-charge distribution in nitrogen compounds; and, molecular spectroscopy by means of ESCA-charge distribution in carbon compounds. (Swed)

37676 STUDIES ON THE RADIOACTIVE DISEQUILIBRIUM OF CERTAIN URANIUM BEARING ORES OF INDIA. PART I. ISOLATION AND ESTIMATION OF URANIUM AND ITS DAUGHTER PRODUCTS. Athavale, V. T.; Parekh, P. P.; Sankar Das, M. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 6: 206-10(1968).

Radioactive equilibrium of a uranium bearing ore is controlled by the relative abundances of ^{238}U, ^{230}Th, ^{226}Ra, ^{222}Rn, and ^{210}Pb of the ^{238}U series, and ^{235}U and ^{231}Pa of the ^{235}U series. Using ion exchange and solvent extraction procedures, schemes of separation and methods of determination of these isotopes were developed. Various isotopes were recovered from a pitchblende ore. In the case of all the isotopes, except ^{231}Pa, the overall precision of the method is of the order of ±4 percent, that of ^{231}Pa being ±6.4 percent. (auth)

37677 SPLAT-COOLED MATERIALS FOR NEUTRON ACTIVATION ANALYSIS STANDARDS. Dorward, R. C. (McMaster Univ., Hamilton, Ont.). J. Nucl. Mater., 27: 235-6 (Aug. 1968).

A method is described by which homogeneous and radiochemically pure alloy standards for neutron activation analysis have been prepared. The method uses levitation melting and extremely rapid solidification by splat cooling. (M.C.G.)

37678 1968 BOOK OF ASTM STANDARDS WITH RELATED MATERIALS. PART 30. GENERAL TESTING METHODS; RADIOISOTOPES AND RADIATION EFFECTS; STATISTICAL METHODS; APPEARANCE OF MATERIALS; EMISSION, MOLECULAR, AND MASS SPECTROSCOPY; SENSORY EVALUATION OF MATERIALS AND PRODUCTS; CHROMATOGRAPHY; TEMPERATURE MEASUREMENT; SPACE SIMULATION; MICROSCOPY. Philadelphia, American Society for Testing and Materials, 1968. 1271p. $21.00.

Part 30 of The 1968 Book of ASTM Standards, which consists of 32 parts, is presented. All current formally approved ASTM standard and tentative specifications, methods of test, recommended practices, definitions, and other related materials, such as proposed methods are included. (D.H.M.)

37679 1968 BOOK OF ASTM STANDARDS WITH RELATED MATERIAL. PART 32. CHEMICAL ANALYSIS OF METALS; SAMPLING AND ANALYSIS OF METAL BEARING ORES. Philadelphia, American Society for Testing and Materials, 1968. 930p. $18.00.

Part 32 of The 1968 Book of ASTM Standards is presented. Major topics included are: general recommended practices; sampling methods; chemical analysis of ferrous metals; chemical analysis of nonferrous metals including Ni–Cr–Fe alloys, Ni and Ni–Cu alloys, Cu and Cu-base alloys, Al and Al-base alloys, Mg and Mg-base alloys, Ti and Ti-base alloys, Zr and Zr-base alloys, Mo, Nb, Pb, Sn, Sb, Ag alloys, and Zn and Zn-base alloys; chemical analysis of metal powders; spectrochemical analysis methods; sampling and analysis of metal-bearing ores; and microchemical analysis. (D.H.M.)

37680 NEUTRON-ACTIVATION DETERMINATION OF Re IN MOLYBDENUM CONCENTRATES. Gureev, E. S.; Islamov, T.; Lobanov, E. M.; Miranskii, I. A.; Khaidarov, N. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz-Mat. Nauk, No. 1, 56-8(1968). (In Russian).

A neutron activation method for determination without decomposition of the irradiated specimens was studied. Because of the nuclear characteristics of rhenium ($^{185,187}Re$ σ = 100 and 75 barns, $T_{\frac{1}{2}}$ = 88.9 and 18.9 hr, and E_γ = 0.137 and 0.155 MeV) it was possible to determine small amounts of it in large amounts of molybdenum. The spectra of irradiated concentrates were measured in a multichannel γ spectrometer and analyzed according to the total photopeak of isotopes at 0.137 and 0.155 MeV. Sensitivity of Re determination in molybdenum concentrates irradiated by the total neutron flux (1.8×10^{13} neutron/cm^2 sec) varied within the limits of 1 to 2×10^{-2}%. ^{187}W interfered with the determination. However, chemical and activation determination of Re in Mo concentrates showed identical results. (R.V.J.)

37681 RADIOACTIVATION METHOD FOR DETERMINING MICROIMPURITIES IN VANADIUM PENTOXIDE. Ganiev, A. G.; Nazmitdinov, M. K.; Sabirov, S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz-Mat. Nauk, No. 1, 40-3(1968). (In Russian).

Results are given of radioactivation determination of As, Mo, W, and Sb in vanadium pentoxide by chemical decomposition of specimens and Au, Mg, and Co without specimen decompositions. Activity of the radioisotopes was measured and identified and their γ spectra obtained in a 100-channel analyzer with a NaI(Tl) crystal. The results obtained were 1.6×10^{-6}% As, 2×10^{-6}% Sb, 2×10^{-5}% W, and 2×10^{-6}% Mo. Gamma spectra of ^{187}W, ^{122}Sb, ^{198}Au, ^{54}Mn, and ^{60}Co standards and separated specimens are given. The results of specimen analysis of V_2O_5 showed 1.8×10^{-4}% Au, 2.5×10^{-5}% Mn, and 4.7×10^{-5}% Co. The standard sensitivity of Au, Mn, and Co is about 1×10^{-7} to 1×10^{-6} g. The order of error is within 20 to 30%. (R.V.J.)

37682 EXTRACTION-RADIOMETRIC DETERMINATION OF SILVER AS DIETHYLDITHIOPHOSPHATE. Abdusalyamov, N.; Ganiev, A. A.; Busev, A. I. (Inst. of Nuclear Physics, Tashkent. Moscow State Univ.). Zh. Anal. Khim., 23: 990-3(July 1968). (In Russian).

A simple and rapid method has been developed for separating silver from lead, copper, and other elements. The possibility of the extraction radiometric determination of silver in galenites by means of sodium diethyl dithiophosphate containing phosphorus-32, was demonstrated. (auth)

37683 STUDY OF THE CHEMICAL ETCHING PROCEDURE USED TO REMOVE SURFACE OXYGEN CONTAMINATION IN CHARGED PARTICLE ACTIVATION ANALYSIS. Rook, Harry L.; Schweikert, Emile A.; Wainerdi, Richard E. (Texas A and M Univ., College Station). Anal. Chem., 40: 1194-6(July 1968).

In charged-particle activation analysis, the procedure used to eliminate surface oxygen contamination is to use a single post-irradiation chemical etch deep enough to remove the activated surface layer including recoil activity. Fluorine-18 is the radioisotope produced by most analytically useful charged particle reactions with oxygen. It is assumed with this procedure that adsorbed activity from the etching solution onto the sample surface can be neglected. However, the results of this experimental study show that adsorbed fluorine-18 activity can become a significant source of error in the determination of oxygen in aluminum matrices. For example in the case of helium-3 activation, the determination of 10 ppB oxygen would be affected by an error of approximately 500%. This potential interference can be eliminated by using a post-irradiation etching procedure which employs two successive etches, the first to remove the activated oxide layer and recoil activity, and the second, of less than 5 microns per face, to remove adsorbed activity. (auth)

37684 GAS CHROMATOGRAPH–COMBUSTION–CONTINUOUS COUNTING SYSTEM FOR ANALYSIS OF MICROGRAM AMOUNTS OF RADIOACTIVE METABOLITES. Martin, R. O. (Univ. of Saskatchewan, Saskatoon, Can.). Anal. Chem., 40: 1197-1200 (July 1968).

The total effluent of a gas chromatograph is passed over copper oxide at 800°C followed by measurement of the carbon dioxide formed with a microthermistor detector. The radioactivity of the carbon dioxide after mixing with propane is measured by a simple proportional counter. There are no split flow corrections, and errors in specific activities caused by combustion variability are minimized. This approach is useful over a large range of organic

compounds up to molecular weights near 400. The mass detector is sensitive to less than 0.1 μg and shows a linear response over a 2000-fold concentration range; 200 to 100,000 dpm of ^{14}C can be detected in a given peak. Both mass detector and proportional counter operate without contamination at ambient temperature. (auth)

37685 THEORETICAL-SLOPE METHOD OF END POINT DETECTION. Dean, J. R.; Harris, W. E. (Univ. of Alberta, Edmonton). Anal. Chem., 40: 1213-16(July 1968).

When reactions go to completion, the end point in an amperometric or photometric titration can be precisely and accurately located by the so-called tangent or extrapolation method. A theoretical-slope method is proposed for titrations involving a metal ion indicator in which the extrapolation method is unsuitable because the ratio of conditional equilibrium constants is too low. The proposed theoretical-slope method was used to detect the end point in the titration of 5×10^{-5} mole of gadolinium, samarium, neodymium, or zinc by using cadmium as the amperometric indicator and EDTA as the titrant. An accuracy and relative precision of 1 to 3% was obtained. In each of these systems, the experimentally determined ratio of the conditional equilibrium constant of the metal–titrant complex to the conditional equilibrium constant of the amperometric indicator–titrant complex was less than 10. (auth)

37686 DETERMINATION OF STOICHIOMETRY OF VANADIUM AND TITANIUM OXIDES BY 14-MeV NEUTRON ACTIVATION. Persiani, Carmine; Cosgrove, James F. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Anal. Chem., 40: 1350-2(July 1968).

Vanadium and titanium oxides and mixtures of the two were analyzed by neutron activation methods. A neutron generator supplied the 14.5-MeV neutrons. The results were in good agreement with theoretical predictions. For the elements analyzed and under the conditions used, the precision was found to be 3 to 5 relative per cent at 95% confidence level. (M.C.G.)

37687 DETERMINATION OF PARTS-PER-MILLION QUANTITIES OF ^{236}Pu IN ^{238}Pu BY ALPHA PULSE HEIGHT ANALYSIS. Curtis, Mary Lou (Monsanto Research Corp., Miamisburg, Ohio). Anal. Chem., 40: 1352-4(July 1968).

A method of determining ppM quantities of ^{236}Pu in ^{238}Pu by alpha pulse height analysis is described. Samples were prepared by electroplating the solutions onto polished slides to get a uniformly thin sample deposit. A minimum of 5 200-min measurements were made with each sample. No pulse pile-up was observed when a maximum of 5×10^3 alpha particles per minute were allowed to impinge on the sensitive area of the detector. (M.C.G.)

37688 LIQUID SCINTILLATION COUNTING TECHNIQUES FOR THE RADIOASSAY OF [^{14}C] MELANIN. Bull, Alan T. (London Univ.). J. Label. Compounds, 4: 181-91(Apr.-June 1968).

Radioactive melanin was extracted from the cell walls of the fungus Aspergillus nidulans after growth in the presence of ^{14}C labeled precursors. The counting systems investigated comprised solid samples suspended in a liquid scintillator with or without silica gel, solubilized samples blended in a liquid scintillator and solubilized samples adsorbed onto glass-fiber discs which were suspended in a liquid scintillator. Results obtained by counting solid samples with an end window detector were compared with the liquid scintillation data. High counting efficiencies were realized with the glass-fiber disc method which is recommended for the assay of soluble samples. Liquid scintillation counting of silica gel suspensions was found to be vastly superior to end window counting for the assay of solid samples. The data suggest that ^{14}C-labeled materials of a particulate or highly pigmented nature can be counted with high efficiency in a liquid scintillation system. (auth)

37689 IDENTIFICATION OF MOLYBDENUM SILICIDES WITH THE HELP OF ELECTRON BEAM MICROANALYSIS. Horn, Hans Christoph; Arlt, Hans Horst (Technische Hochschule, Vienna). Z. Metallk., 59: 553-4(July 1968). (In German).

Electron microprobe analysis was employed to analyze molybdenum silicides in copper, which were produced using the auxiliary metal bath procedure. With silicon concentrations between 2 and 12% in the copper melt a molybdenum silicon solid solution containing 1% Cu (at a reaction temperature of 1200°C), and the phases Mo_3Si, Mo_5Si_3, and $MoSi_2$, respectively, could be identified. A zone-like arrangement of the phases was not observed. (auth)

37690 IMPROVED MASS-SPECTROMETRIC ISOTOPIC ANALYSIS USING AN AMPLITUDE SELECTOR FOR PULSE COUNTING WITH A SCINTILLATION ION DETECTOR. Tyrrell, A. C.; Ridley, R. G.; Daly, N. R. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Mass Spectrom. Ion Phys., 1: 69-73(Apr. 1968).

Isotopic analyses of solid samples by mass spectrometry can be difficult to obtain accurately if instrument background peaks are present. A method is described that reduces this background by over a factor of ten using an amplitude selector in the ion pulse counting system of a scintillation detector. The method utilizes the difference in secondary electron coefficients obtained from metal and polyatomic ions. As examples of performance the mass spectra of molybdenum and uranium were studied. (M.C.G.)

37691 DEVICE FOR TRANSPORTING AN ACTIVATION-ANALYSIS SAMPLE MATERIAL. Hashimoto, Kenjiro (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-19558. Oct. 2, 1967. Filed July 20, 1964.

A device is described that ensures that a sample for activation analysis does not come out of its containing case during transportation through a pneumatic tube between the irradiation room and radiation-measuring room. The sample is contained in a stoppered case during transport through the pneumatic tube. A ring is installed on the case stopper concentric with the pneumatic tube, and the inner circular edge of the ring protrudes slightly into the pneumatic tube. The protrusion has a tiny tapered projection at the top in the direction of the irradiation room. The end of the case itself has an axial protrusion extending from the case on the side of the radiation measuring room. Before hitting the stopper, the sample material is held inside the case by tiny inward projections on the top of this protrusion on the case. On hitting the stopper, the projection on the stopper and the protrusion on the case engage each other to cause the protrusions on the case to be pried out to release the sample. (NSA of Japan)

37692 SENSITIVITY OF MICROAUTORADIOGRAPHIC DETERMINATION OF α-RADIOACTIVE ISOTOPES. Korobkov, V. I.; Zaborenko, K. B. Radiokhimiya, 9: 745-8(1967). (In Russian).

Sensitivity of the microautographic method for determining α-radioactive isotopes was studied using three methods of introducing the isotope into the photographic emulsion (saturation of the photographic emulsion in a solution, spilling the solution on the photolayer, and spraying the solution on the photographic emulsion). Formulas are given for calculating the sensitivity for each method using ^{232}Th isotope. The results showed that the sensitivity depends on the manner the isotope is introduced and that the electrocapillary spraying method produced the highest sensitivity. The order of error in determining the sensitivity of the method using ^{232}Th was found. (R.V.J.)

37693 EXPERIENCE IN RADIONUCLIDE ANALYSIS BY GAMMA-RAY SPECTROMETRY AND COMPUTER. Brown, P. E.; Davis, I. J. (Atomic Energy Research Establishment, Harwell, Eng.). Radiochim. Acta, 9: No. 1, 41-7(May 1968).

Routine analysis of radionuclides by γ-spectrometry and computer can produce results which are on a par with those obtained by wet chemical methods. The equipment can be automated and once stabilized and calibrated can be operated by semi-skilled staff. (auth)

37694 DETERMINATION OF Hf IN Ti AND Ti COMPOUNDS. Lobanov, E. M.; Blinkov, D. I.; Dutov, A. G.; Zinov'ev, N. V. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 94-5(1968). (In Russian).

Activation analysis was used for determining Hf in Ti and Ti compounds. Irradiation of Hf by a thermal neutron flux produces the radioisotopes $^{174}Hf(n,\gamma)^{175}Hf$ with $T_{\frac{1}{2}}$ = 70 days and $^{180}Hf(n,\gamma)^{181}Hf$ with $T_{\frac{1}{2}}$ = 16 days, and $^{178}Hf(n,\gamma)^{179}Hf$ with $T_{\frac{1}{2}}$ = 19.5 sec. A pneumatic high-speed device was used in the determination. The spectrum of TiO_2 with maximum rf content 6 sec and 6 min after irradiation showed 60 and 220 keV peaks for ^{179m}Hf, 150 keV for ^{46m}Sc, and 320 keV for ^{51}Ti. (R.V.J.)

37695 DETERMINATION OF CERTAIN ELEMENTS IN COAL BY ACTIVATION ANALYSIS USING 14.5-MeV NEUTRONS. Sattarov, M.; Talanin, Yu. N.; Khalikov, T. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 74-7(1968). (In Russian).

Activation analysis with (D–T) neutrons of 14.5 MeV energy was used for determining impurities (Al, Si, Fe, Cu, Mg, Na, and Ba) in bituminous coal specimens. (R.V.J.)

37696 ACTIVATION ANALYSIS IN STEEL PRODUCTION. Van Erkelens, Pieter C. (EURATOM, Geel, Belg.). Euratom Rev., 7: 59-61(June 1968).

Recent advances in the development of neutron activation techniques for the determination of oxygen in steel are reviewed. An automatic apparatus has been developed which features the

simultaneous irradiation and counting of standard and sample and the direct printing of results in parts per million of oxygen. The apparatus can handle as many as 30 steel samples, weighing up to 40 g, per hour. The method makes possible the precise and rapid determination of oxygen in steel. (J.G.B.)

37697 CONTINUOUS DETERMINATION OF SULPHUR IN OIL PRODUCTS BY THE ABSORPTION OF THE BREMSSTRAHLUNG OF TRITIUM. Solt, J.; Fodor-Csanyi, P.; Polgar, A. Magy. Kem. Foly., 74: 190-2(1968). (In Hungarian).

The sulfur content in oil products can be continuously determined by the selective absorption of the bremsstrahlung of tritium. A compensation method was developed that allows the direct observation of an intensity difference which is proportional to the sulfur content. (auth)

37698 SPECTRUM STRIPPING TECHNIQUE FOR QUALITATIVE ACTIVATION ANALYSIS USING MONOENERGETIC GAMMA SPECTRA. Furr, A. K.; Robinson, E. L.; Robins, C. H. (Virginia Polytechnic Inst , Blacksburg). Nucl. Instrum. Methods, 63: 205-9(Aug. 1968).

A qualitative neutron activation analysis technique has been developed using a library of spectra consisting of monoenergetic gammas instead of isotopic spectra. The library is employed with a straightforward spectrum stripping computer program which provides rapid identification of the constituents in an unknown sample. The use of a library of this type requires a much smaller library and eliminates some of the difficulties associated with the mathematical procedures normally used in computer-coupled activation analysis. The methods used to obtain these spectra and the computer program are briefly outlined. A test case is presented which illustrates the efficiency of the computer program. (auth)

37699 ULTRA-SENSITIVE DETERMINATION OF LITHIUM BY NEUTRON ACTIVATION ANALYSIS. Lukens, H. R.; Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 314-16 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

A neutron activation analysis method has been developed for the determination of very small amounts of lithium in various materials. A pulsing TRIGA nuclear reactor, a rapid pneumatic sample-transfer system, and a Cherenkov counter are used, respectively, to obtain high specific yields from the $^{7}Li(n,\gamma)^{8}Li$ reaction, bring the 0.84-second half life product radionuclide to the counter, and count the 13.1 MeV (E_{max}) beta particles from ^{8}Li. As little as 10^{-9} gram of lithium can thus be detected, in the absence of appreciable interferences. (auth)

37700 DETERMINATION OF OXYGEN IN TITANIUM AND REFRACTORY METALS BY ACTIVATION ANALYSIS. Andersen, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 317-22 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

A fast-neutron activation analysis method is described for the determination of oxygen in titanium and refractory metals and alloys. Equipment is described which enables the operator to analyze a wide variety of sample sizes nondestructively, rapidly, accurately, and sensitively. (auth)

37701 USES OF NEUTRON ACTIVATION AND GAMMA RAY SPECTROMETRY IN PROBLEMS OF DRUG CONTROL. Reynolds, Leon Martindale. Lafayette, Ind,, Purdue Univ., 1966. 130p.

Thesis.

The arbitrary introduction of certain trace elements into drug products during manufacture, for identification of the source of the product at any future time by neutron activation analysis, was investigated. To establish levels required for the additives it was necessary to examine closely the natural contaminants already present. Samples of dextroamphetamine tablets and capsules from five manufacturers were analyzed for natural contaminants along with related common ingredients. A perusal of published data yielded 15 potential additives and seven of these were studied in four-component systems, namely Au, MnO_2, CuO, Dy_2O_3, La_2O_3, Eu_2O_3, and Sm_2O_3. Dry powders were used, diluted where necessary for weighing, with lactose powder. Sensitivities relative to Au were determined. Differentiation based on quantitative measurement of levels is possible if one additive is visualized as a standard and the other three varied and measured with respect to it. The usefulness of the system of additives will depend on the levels of the trace elements already present in the drug project. Too high a level of natural contaminants will require the addition of larger amounts of additives than physiological considerations will permit. Thus, each drug product will have to be considered individually after first establishing its natural trace element content. Eighteen drugs and common drug diluents were analyzed for natural contaminants. In the group, 17 elements were detected, in amounts ranging from <1 ppB to over 0.1%. The contaminants present in the six different dextroamphetamine tablets and capsules from the five different manufacturers indicated that each of the products was readily distinguishable from the others. (Disser. Abstr.)

37702 RADIOCHEMISTRY OF IRON. Allam, Saadia A. L. Ibrahim. Detroit, Wayne State Univ., 1963. 71p.

Thesis.

Two isotopes of iron are formed in the triple fission of uranium; ^{59}Fe and ^{60}Fe. The need for a rapid and accurate method for separating and determining radioiron is considered. A method was developed for the separation of radioiron from uranium fission by extraction of $FeCl_3$ with diisopropyl ether from 9M HCl. The main interference caused by Zr was eliminated by separation from radioiron as zirconyl thiomalate. The radioiron was γ counted in a volume of 4 ml directly after separation, and the counts corrected for gravimetric recovery. The recovery of the iron carrier was determined spectrophotometrically by measuring the optical density of the red-purple iron thioglycollate solution at 535 mμ. A method was developed for the radiometric determination and separation of iron(III). Sodium benzenesulfinate is used for the precipitation of ferric benzenesulfinate from 0.1M HCl. The precipitate is dried at 110°C and weighed directly as Fe $(C_6H_5SO_2)_3$, then γ counted. (Disser. Abstr.)

37703 ANALYSIS OF SINGLE CRYSTAL SILICON SLICES BY NEUTRON ACTIVATION. Lunde, Gulbrand (Central Inst. for Industrial Research, Oslo). Solid State Technol., 11: 32-8 (Jan. 1968).

The possibility of studying the distribution and concentration of impurities in or on treated single-crystal Si slices by neutron activation was investigated. This method of analysis can also be employed during further treatment of the Si slices in studying etching, diffusion, and other processes. Different B-doped (p-type) Si single-crystal slices delivered from various producers in Europe, the USA, and Japan were studied. In addition to analyzing the impurities nondestructively using a γ spectrometer, autoradiographs of the Si slices were taken by placing them in contact with a photographic emulsion. The possibilities for studying the distribution of the different impurities in the crystals by comparing the γ spectra with autoradiographs are discussed. The following impurities were found and analyzed: Au, Cu, Zn, Sc, Zr, Hf, La, and Na. It was concluded that the method should be of considerable value for the fabricators and users of Si single crystal slices in controlling surface contaminants. (BBB)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 37638, 37776, 37795, 37798, and 38635.

37704 (ANL-Trans-610, pp 57-63) [ELECTROCHEMICAL STUDIES]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 4, pp 79-86 of report CEA-N-856.

The first results obtained on the production of frittable UO_2 by igneous electrolysis showed that with the technique used the yield is 80 to 90% and the powder obtained is remarkably well crystallized. The corrosion of Ag in a fused chloride bath was studied and the results showed that a thermal gradient considerably increases the intragranular attack on Ag. In a study of the conductivity of fused salts and of the electrode–fused salt interface it was shown that deviations from the volumetric ideal of the mixtures are less than 1% whereas deviations from the conductimetric ideal are much larger. The conditions for electrocrystallization in fused salts in order to obtain compact deposits of W and Ni were investigated. Measurements were made of the adherence of cadmium deposits on steel, with and without preliminary charging with hydrogen. The results show that in the majority of cases the rupture takes place in the cadmium deposit and not at the cadmium–steel interface. In preliminary tests satisfactory depositions of chromium were obtained on Zr–Cu(2%) alloy, effected on a substrate of Cu. (J.S.R.)

37705 (ANL-Trans-626) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, CENTER FOR NUCLEAR STUDIES AT FONTENAY-AUX-ROSES, DIRECTION OF NUCLEAR MATERIALS AND FUELS, DECEMBER 1966–MAY 1967. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Translation of Sections 8 and 9, pp 238-97 from report CEA-N-856. 59p. Dep. CFSTI.

For abstracts of individual sections see: 37824 and 37825.

37706 (ANL-Trans-628) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, CENTER FOR NUCLEAR STUDIES AT FONTENAY-AUX-ROSES, DIRECTION OF NUCLEAR MATERIALS AND FUELS, DECEMBER 1966–MAY 1967. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Sections 10 and 11, pp 299-427 of report CEA-N-856. 128p. Dep. CFSTI.

For abstracts of individual sections see: 37640 and 37826.

37707 (BNL-50082, pp 27-39) CHEMISTRY DIVISION. Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y.).

Developments are reported for studies on: double-layer capacitances in liquid metal–molten salt interfaces; transport in molten salt mixtures; thermodynamic properties of molten $CeCl_3$ mixtures by electromotive force measurements; halogen–metal halide solutions; pyrolysis of perfluorobicyclohexyl; radical intermediates; fluorocarbon reactions; the graphite–hydrogen reaction; spectroscopy of carbon–hydrogen system; metal hydrides; and electrode kinetics. (P.C.H.)

37708 (BNWL-786) PLUTONIUM RELEASE STUDIES. III. RELEASE FROM HEATED PLUTONIUM BEARING POWDERS. Mishima, J.; Schwendiman, L. C.; Radasch, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

Four plutonium compounds in powder form, the oxide, partially oxidized oxalate, oxalate, and fluoride, were subjected to high temperature in air drawn up and around the material at various velocities. Under the conditions of these experiments, the greatest amount, at a rate of 0.90 wt %/hr, was released by plutonium oxalate at 700°C in an upsweep of air at 100 cm/sec. The partially oxidized oxalate, the most readily entrained, showed significant release rates at all air velocities at 1000°C, and at all temperatures in air moving at 100 cm/sec. Release rates ranged from 0.25 to 0.82 wt%/hr at 1000°C and 0.057 to 0.82 wt%/hr in air with a velocity of 100 cm/sec. The smallest fraction was released by the fluoride during the runs, 0.05 wt%/hr at 1000°C in an air velocity of 100 cm/sec. The residue remaining from the overheating of the fluoride appeared susceptible to further entrainment. (auth)

37709 (CEA-N-856) RAPPORT SEMESTRIEL DU DEPARTEMENT DE CHIMIE, DECEMBRE 1966–MAI 1967. (Semiannual Report of the Chemistry Department, December 1966–May 1967). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1967. 450p. (In French). Dep.

The semiannual report of the Chemistry Department is presented. Abstracts were prepared for four sections: treatment of average and weakly active effluents, treatment of uranium, corrosion studies, and active technology. Two sections on miscellaneous chemical studies were not covered by separate abstracts. The remaining seven sections were abstracted as: ANL-Trans-612 for sections 1 and 4, ANL-Trans-619 for section 7, ANL-Trans-626 for sections 8 and 9, and ANL-Trans-628 for sections 10 and 11. (M.C.G.)

For abstracts of individual sections see: 37639, 37640, 37704, 37823–37826, 37829–37831, and 38513.

37710 (CEA-R-3215) L'HYDROLYSE DU DICARBURE DE THORIUM ET DES DICARBURES MIXTES D'URANIUM ET DE THORIUM. (Hydrolysis of Thorium Dicarbide and of Mixed Uranium–Thorium Dicarbides). Del Litto, Bernard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 68p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

The hydrolysis of thorium dicarbide leads to the formation of a complex mixture of gaseous and condensed hydrocarbons. The temperature, between 25 and 100°C, has no influence on the nature and composition of the gas phase. The reaction kinetics, however, are strongly temperature dependent. In a hydrochloric medium, an enrichment in hydrogen of the gas mixture is observed. A decrease in hydrogen and an increase in acetylene content take place in an oxidizing medium. The general results can be satisfactorily interpreted through a reaction mechanism involving $\geqslant C-C \leqslant$ radical groups. The hydrolysis of uranium–thorium–carbon ternary alloys leads to the formation of gaseous and condensed hydrocarbons. The variation of the composition of the gas phase versus uranium content in the alloy suggests an hypothesis about the carbon–carbon distance in the alloy crystal lattice. The variation of methane content led to a discussion of the nature of the various phases present in U–C alloys and carbon-rich U–Th–C alloys. It was concluded that these alloys include a proportion of monocarbide that is dependent upon the ratio Th/Th + U. A diagram of the U–C system is presented with features to explain some phenomena observed in the U–Th–C ternary diagram. (auth)

37711 (CEA-R-3301) ETUDE CINETIQUE DE L'OXYDATION DES METAUX ALCALINS PAR L'OXYGENE SEC. (Kinetic Study of the Alkaline Metals Oxidation by Dry Oxygen). Touzain, Philippe (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 101p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

The oxidation of lithium, sodium, potassium, rubidium, cesium, and sodium–potassium alloys by dry oxygen was studied at several temperatures and in the oxygen pressure range from 40 to 400 mm Hg. Three different oxidation behaviors (flammability, ignition, and slow combustion) whose zones are distinguished as a function of the temperature were found. The slow oxidation kinetic laws, the composition of oxides, and the cause of oxide colorations were determined. The experimental data are construed theoretically. (auth)

37712 (COO-773-15) [LUMINESCENCE OF METAL COMPLEXES]. Annual Technical Progress Report, 1967–68. (Arizona Univ., Tucson). June 15, 1968. Contract AT(11-1)-773. 5p. Dep. CFSTI.

Developments are reported for studies on: polarization of electronic transitions in chromium acetylacetonate; relaxation of ^2E states in Cr(III) complexes; low temperature spectra of Cr(III) complexes; and ESR studies on $Cr(C_2O_4)_3^{3-}$. (P.C.H.)

37713 (LA-3902) MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES. I. THE HEATS OF VAPORIZATION OF GOLD AND PLUTONIUM AND THE HEAT OF DECOMPOSITION OF PLUTONIUM MONONITRIDE. Kent, R. A.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Feb. 29, 1968. Contract W-7405-eng-36. 20p. Dep. CFSTI.

The mass spectrometer–Knudsen cell apparatus, constructed and employed to measure the enthalpy of vaporization of gold, the vapor pressure and enthalpy of vaporization of plutonium, and the partial pressures and enthalpies of formation of Pu(g) and N_2(g) above solid PuN, is described. In the temperature range from 1426 to 1658°K, liquid plutonium vaporizes predominately to the monomer with the vapor pressure given by the least-squares equation: $\log_{10} P(atm) = (4.924 \pm 0.120) - 17420 \pm 184/T°K$. The standard enthalpy of vaporization is $\Delta H^0_{298} = 83.0 \pm 0.5$ kcal. mole^{-1}. In the temperature range from 1658 to 1976°K, PuN(s) decomposes invariantly according to the reaction, $PuN(s) = Pu(g) + 1/2\ N_2(g)$, with an enthalpy of reaction $\Delta H^0_{298} = 156.1 \pm 2.5$ kcal. mole^{-1}. The partial pressure of Pu(g) above solid PuN is given by: $\log_{10} P_{Pu}(atm) = (6.436 \pm 0.055) - 21958 \pm 98/T°K$. The standard enthalpy of formation of solid PuN is calculated to be $\Delta H^0_{f298} = -73.1 \pm 2.7$ kcal. mole^{-1}. (auth)

37714 (MLM-1513) A REVIEW OF THE DISSOLUTION OF PLUTONIUM DIOXIDE. PART II. Gilman, W. S. (Mound Lab., Miamisburg, Ohio). Aug. 7, 1968. Contract AT-33-1-GEN-53. 12p. Dep. CFSTI.

The presently available dissolution data for plutonium dioxide were compiled together with a bibliography on the subject. The ease of solubility of PuO_2 in various media is dependent on the method of its preparation, the impurities present, and the temperature at which the PuO_2 was calcined or sintered. (35 references) (auth)

37715 (ORNL-4257) EMF STUDY OF LiF–BeF_2 SOLUTIONS. Hitch, B. F.; Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 46p. Dep. CFSTI.

The potential of the cell $Be^0|BeF_2, LiF|HF,H_2,Pt$ with the assumed cell reaction, $Be(s) + 2HF(g) \rightleftharpoons BeF_2(d) + H_2(g)$, was measured over a composition range from 0.30 to 0.90 mole fraction BeF_2 and a temperature range from 500 to 900°C. Since this cell potential is related to the activity of BeF_2 in the solutions by $E = E^0 - RT/2F \ln P_{H_2} a_{BeF_2}/P^2_{HF}$, activity coefficients could be derived for BeF_2 (and by a Gibbs–Duhem integration for LiF). Usefully accurate measurements could not be made with pure BeF_2 in the cell, hence values of E^0 were calculated using values for a_{BeF_2} derived from the phase diagram and previously reported heat of fusion (1.13 kcal/mole) giving $E^0 = 2.4430 - 0.0007952T$. This comparison of the emf data with the LiF–BeF_2 phase diagram also indicated that the heat of fusion for BeF_2 is <2.0 kcal/mole. A power series in x_{LiF} was assumed for $\log \gamma_{BeF_2}$ and the coefficients determined by a least squares fit to the data. This gave $\log \gamma_{BeF_2} = (3.8780 - 2353.5/T)\ x^2_{LiF} + (-40.7375 + 36292.8/T)\ x^3_{LiF} + (94.3997 - 84870.9/T)\ x^4_{LiF} + (-67.4178 + 52923.5/T)\ x^5_{LiF}$. Formation free energies and heats for BeF_2 and BeO were also calculated by combining the results of the present study with available thermochemical data. The $Be^{2+}|Be^0$ and $Hf,H_2|F^-$ electrodes performed acceptably for use as reference electrodes, both being stable and reproducible. (auth)

37716 (RD/B/N-1134) THE IGNITION OF URANIUM. PART I. A LITERATURE SURVEY. Pearce, R. J. (Central Electricity

Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1968. 20p. Dep. CFSTI.

Available data on the ignition of U in air, O_2, and CO_2 are reviewed. Although many aspects have been investigated, the information is not exhaustive, and a number of gaps in knowledge are obvious. Nevertheless, the major factors that affect ignition in air or O_2 were identified. Information on ignition in CO_2 is much more restricted. A brief survey of the reactivity of uranium hydride is also included. (35 references). (UK)

37717 (UCRL-17989, pp 159-66) HYPERFINE INTERACTIONS. (California Univ., Berkeley. Lawrence Radiation Lab.).

Research is reported on the hyperfine structure of optically excited states of radioisotopes, spin and attenuation coefficients of the 86.5- and 105.3-keV states in ^{155}Gd, and hyperfine structure in the ^{253}Es emission spectrum. (M.C.G.)

37718 (UCRL-17989, pp 181-252) CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Developments are reported for studies on: spectra of einsteinium iodide; extension of the analysis of the Cm^{I} and Cm^{II} spectra; observations of the solar eclipse of Nov. 12, tetravalent Np induced in CaF_2 by γ irradiation; amalgamation behavior of heavy elements; dipositive state of Md; extraction of $HClO_4$ and $HReO_4$ by dilute solutions of TBP in CCl_4, isooctane, 1,2-di-chloroethane, benzene, 1,3,5-triethylbenzene, and $CHCl_3$; solvent extraction of perchloric acid and the solvation of the proton; solvent extraction of tetrabutylammonium nitrate and the solvation of the nitrate ion; solvent extraction of tetraheptylammonium fluoride and the solvation of the fluoride ion; crystal and molecular structure of cembrene; crystal and molecular structure of 1-bromo-triptycene, $Br-C_{20}H_{13}$; and amperometric titration of Pd(II) by oxidation with hypochlorite. (P.C.H.)

37719 (UCRL-Trans-10235) HYDROLYSIS OF THORIUM FLUORIDE IN FUSED SALTS. Smirnov, M. V.; Ilyushchenko, N. G. Translated by A. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Izv. Vost. Filialov Akad. Nauk SSSR, No. 4-5, 114-18(1957). 13p. Dep. CFSTI.

Hydrolysis of hydrated thorium fluoride $ThF_4 \cdot 1.57\ H_2O$ in molten alkali metal chlorides was studied at 700°C. Addition of the fluoride to the chloride melt resulted in hydrolytic splitting leading to the formation of hydroxyl ions. The oxygen-containing ions were discharged at the anode at a lower potential than chlorine ions. (auth)

37720 ATOMIC RADII IN SEMI-METALLIC COMPOUNDS OF ROCKSALT STRUCTURE. Allbutt, M.; Dell, R. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 705-10(May 1968).

Consideration of the lattice parameters observed for semi-metal compounds of the type MX where M is a rare earth and X = N, P, As, Sb, S, Se, or Te leads to a definition of characteristic radii for the non-metal atoms. For S, Se, and Te these are close to the Pauling X^{2-} radii, whereas for N, P, As, and Sb the values are less than the calculated X^{3-} radii, indicating some degree of electron delocalisation into the metallic conduction band. Using these anion radii, the cation radii in the corresponding actinide semi-metal compounds are calculated. It is concluded that these compounds generally contain Th^{4+}, U^{4+} or U^{5+}, and Pu^{3+} or Pu^{4+} ionic cores. (auth) (UK)

37721 ON A LEAD URANIUM FLUORIDE OXIDE $Pb_{1.5}U_2O_6F$. Kemmer-Sack, Sibylle (Univ., Tuebingen, Ger.). Z. Naturforsch., 23b: 1010(July 1968). (In German).

The brownish-black $Pb_{1.5}U_2O_6F$ was prepared by the reaction $1\frac{1}{2}\ PbO + UO_2 + \frac{3}{4}\ UO_2 + \frac{1}{4}\ UF_4 \rightarrow Pb_{1.5}U_2O_6F$ at 400 to 750°C. The compound crystallizes in cubic form with a = 11.1 Å and the density is 9.70 g/cm^3. The magnetic susceptibility of the compound was also determined. (M.C.G.)

37722 STABILISATION OF PLUTONIUM TETRABROMIDE AND URANIUM PENTABROMIDE. Brown, D.; Holah, D. G.; Richard, C. E. F. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Commun., 11: 651-2(1968).

The preparation and some properties of stable complexes of $PuBr_4$ and UBr_5 with oxygen donor ligands are reported. Both $PuBr_3$ and UBr_4 are rapidly oxidised by liquid bromine in anhydrous CH_3CN, and in the presence of stoichiometric amounts of triphenylphosphine oxide (TPPO) or hexamethylphosphoramide (HMPA) gave soluble complexes of the types $PuBr_4 \cdot 2L$ and $UBr_5 \cdot L$. Details are given of the isolation and purification of these complexes. The plutonium complexes were found to be isostructural with their known quadrivalent actinide analogues. The phosphine oxide complexes were indefinitely stable in an inert atmosphere. X-ray powder diffraction patterns were recorded, but results have not yet been interpreted. The number of low angle reflections suggests that the complexes possess low symmetry. The absorption spectra in methylene dichloride were very similar to those reported for hexabromoplutonates and for other UCl_5 complexes. Only a single oxidation state was detected and the solutions were quite stable for several days in an inert atmosphere. Some comparisons were made with Nb, Ta, Pa, and Th complexes. Attempts to prepare phosphine oxide complexes of $NpBr_5$ and $AmBr_4$ by the foregoing method were unsuccessful. (UK)

37723 COMPLEXES OF SOME DIHYDROXYBENZOIC ACIDS WITH URANYL ION IN AQUEOUS SOLUTION. Ostacoli, Giorgio; Campi, Ennio; Gennaro, Maria Carla (Univ., Turin). Gazz. Chim. Ital., 98: 301-15(Mar. 1968). (In Italian).

The complexes formed in aqueous solution between UO_2^{2+} ion and 3,5-, 2,4-, and 2,5-dihydroxybenzoic acids (α-resorcylic, β-resorcylic, and gentisic acids, respectively) were studied by potentiometric and spectrophotometric methods at ionic strength 0.2 ($NaClO_4$) and at 25°C. In the solutions containing UO_2^{2+} ion and ligand in the stoichiometric ratio 1:1, complexes of the type MH_2A (H_2A indicates the ligand) with all 3 acids were formed. Only the dihydroxybenzoic acids with a hydroxyl group in the ortho position with respect to the carboxylic group formed, in acid medium, stable complexes of the type MHA. The values of the equilibrium constants and of molar absorptivities are reported. (BBB)

37724 KINETIC DEUTERIUM ISOTOPE EFFECT IN AROMATIC SUBSTITUTION. Pietra, F.; Vitali, D. (Univ. of Pisa, Italy). Chem. Commun., 12: 692-3(June 19, 1968).

It is stated that little is known about the kinetic deuterium isotope effect in nucleophilic aromatic substitution reactions, and this limits knowledge of the reaction mechanisms. Genuine kinetic deuterium isotope effects were found in the reactions of piperidine or [1 – ^{2}H] piperidine with 2,4-dinitrophenyl phenyl ether and 4-chloro-3-nitrobenzotrifluoride in benzene, and were interpreted as primary isotope effects, and it was suggested that failure to observe such isotope effects in other similar reactions resulted from the use of too narrow a range of amine concentrations. Results of a study on the piperidine/chloro-4,7-dinitronaphthalene system throw doubt on this suggestion. Substitution of (1 – ^{2}H) piperidine did not alter the kinetics in the whole concentration range. It is concluded that a primary deuterium isotope effect is by no means normal for these reactions, and the reactions cannot be considered to proceed by rate-limiting ammonium proton transfer from the addition intermediate to a base. It was found that displacement of a very poor "leaving group" like cyclohexyloxy may show a kinetic deuterium isotope effect (reactions of piperidine with cyclohexyl 2,4-dinitrophenyl ether in benzene). (UK)

37725 MECHANISTIC STUDIES IN STRONGLY BASIC MEDIA. PART VI. THE KINETICS OF BASE-INDUCED HYDROGEN-ISOTOPE EXCHANGE AND AUTOXIDATION OF FLUORENE IN t-BUTYL ALCOHOL. Bethell, D.; Talbot, R. J. E. (Univ. of Liverpool, Eng.). J. Chem. Soc., B, No. 6, 638-42(1968).

Deuteron removal from 9,9-dideuteriofluorene by potassium t-butoxide or benzyltrimethylammonium hydroxide in t-butyl alcohol takes place at a rate which is proportional to the ionisation ratio of the indicator p-nitroaniline in the reaction medium. The rate of base-induced autoxidation of fluorene in t-butyl alcohol is given by the equation $v = k[\text{Fluorene}][O_2]\phi$, where ϕ is a function of the basicity of the reaction medium, and is much faster using benzyltrimethylammonium hydroxide than using potassium t-butoxide as the base. Autoxidation of 9,9-dideuteriofluorene in the presence of potassium t-butoxide occurs at the same rate as the autoxidation of fluorene itself. When the quaternary ammonium hydroxide is used, however, the instantaneous rate coefficient increases with time, eventually reaching a steady value equal to that for autoxidation of fluorene. A kinetic expression for this behavior is derived, and from it a value for the kinetic isotope effect on the autoxidation is obtained. The implications of the results are briefly discussed. (auth) (UK)

37726 A KINETIC STUDY OF ISOTOPIC EXCHANGE REACTIONS BETWEEN LANTHANIDE IONS AND LANTHANIDE POLYAMINOPOLYCARBOXYLIC ACID COMPLEX IONS. I. ISOTOPIC EXCHANGE REACTIONS OF Ce(III) WITH Ce(HEDTA), $Ce(EDTA)^-$, $Ce(DCTA)^-$, AND $Ce(DTPA)^{2-}$. Glentworth, P.; Wiseall, B.; Wright, C. L.; Mahmood, A. J. (Univ. of Leeds, Eng.). J. Inorg. Nucl. Chem., 30: 967-86(May 1968).

The rates and mechanisms of the isotopic exchange reactions of Ce(III) ions with the above complex ions were investigated. The rate equations and the experimentally determined rate constants at 20°C, $\mu = 0.1$, and acetate buffer concentration of 10^{-2} M were as follows: Rate = $k_1[H^+][Ce(HEDTA)]$; where $k_1 = 23.1 \times 10^4$ l mole^{-1} min^{-1}. Rate = $k_2[H^+][Ce(EDTA)^-]$; where $k_2 = 9.4 \times$

10^4 l mole^{-1} min^{-1}. Rate = $k_3[H^+][Ce(DCTA)^-] + k_4[Ce(DCTA)^-] + k_5[Ce(III)][Ce(DCTA)^-]$; where $k_3 = 3.9 \times 10^3$ l mole^{-1} min^{-1}; $k_4 = 4.2 \times 10^{-3}$ min^{-1} and $k_5 = 5.6$ l mole^{-1} min^{-1}. Rate = $k_6[Ce(DTPA)^{2-}][H^+]^2 + k_7[Ce(III)][Ce(DTPA)^{2-}]$; where $k_6 = 3.0 \times 10^8$ l^2 mole^{-2} min^{-1} and $k_7 = 1.6$ l mole^{-1} min^{-1}. The mechanisms of the exchange reactions of the multidentate chelates are discussed in terms of the lability of the carboxylic acid groups. The exchange reactions are catalysed by acetate ions, and the effects of increased acetate concentration on the various terms of the rate equations were examined. Activation energies were also determined. (auth) (UK)

37727 STUDIES ON HYDROGEN EXCHANGE. VIII. THE BASE-CATALYSED HYDROGEN EXCHANGE OF METHYL HYDROGENS OF METHYLPYRIDAZINES AND THEIR N-OXIDES. Kawazoe, Yutaka; Yoshioka, Yuko; Yamada, Mutsumi; Igeta, Hiroshi. Chem. Pharm. Bull. (Tokyo), 15: 2000-2(Dec. 1967).

The π-electronic structure of pyridazine and its N-oxide was studied by the base-catalysed H−D exchange reactivity of the methyl hydrogens of monomethylpyridazines and their N-oxides. Thus, this type of hydrogen exchange can be considered to be initiated by a nucleophilic attack of the base on hydrogen, followed by cleavage of C−H bond to yield a carbanion and a proton as reaction intermediate, as previously shown for pyridine and quinoline derivatives. These molecules can be regarded as a weak acid to dissociate an acidic proton. As a result, the exchange reactivity should be directly related to the π-electronic structure of this aromatic ring. Hydrogen exchange reactions were carried out as follows. The compounds examined were 3- and 4-methylpyridazines and 3-, 4-, 5-, and 6-methylpyridazine 1-oxides. They were dissolved to 5% concentration in D_2O (99 D-atom %) containing 1% NaOD and sealed in an NMR sample tube. The reaction tubes were heated to an appropriate temperature for an appropriate period. The relative exchange reactivities of these isomeric methyl hydrogens were determined by NMR spectroscopy, i.e., by qualitative comparison of the remaining signal of the methyl hydrogens concerned. The results obtained are tabulated and the reaction conditions for preparation of deuterated derivates are shown. In pyridazine free bases, the fact that 4-methyl hydrogens (β to one N and γ to the other) are more readily replaced by D than the 3-methyl ones (α to one N and β to the other) indicates that γ-methyl of pyridine is more reactive than the α form. Contrary to this, the following unexpected order of the exchange reactivity was found in the series of monomethylpyridazine 1-oxides: 6-CH_3 > 5-CH_3 > 4-CH_3 = 3-CH_3. (BBB)

37728 CRYSTALLOGRAPHIC STUDY OF THE ORTHORHOMBIC TO CUBIC PHASE TRANSITION IN YTTERBIUM DIHYDRIDE. Messer, C. E.; Gianoukos, P. C, (Tufts Univ., Medford, Mass.). J. Less-Common Metals, 15: 377-83(Aug. 1968).

The crystal structures of ytterbium and calcium dihydrides were investigated at temperatures from 25 to 600°C by x-ray diffraction. The gradual transition of ytterbium dihydride from orthorhombic to face-centered cubic, beginning at 125°C, was found. The kinetics of the transition were studied at 200° and 250°C. Two cubic phases of lattice constants 5.192 ± 0.004 Å and 5.253 ± 0.015 Å were confirmed. The latter was definitely metastable; the former was stable at room temperature for the duration of the investigation. Surface oxidation at and above 400°C prevented investigation of a similar expected transition in calcium hydride. Coefficients of expansion and volume changes on transition were calculated. The role of polarization in the transition is discussed. (auth)

37729 PROTONATED CYCLOPROPANES. II. THE SOLVOLYSIS OF CYCLOPROPANE IN TRITIATED SULFURIC ACID. Lee, C. C.; Gruber, L. (Univ. of Saskatchewan, Saskatoon). J. Amer. Chem. Soc., 90: 3775-8(July 3, 1968).

Passage of cyclopropane at room temperature for 3 hr through 9.2 M or 13.8 M H_2SO_4-t resulted in the formation of 1-propanol and 1-propyl hydrogen sulfate. The 1-propanol recovered with the aid of inactive carrier, before or after the hydrogen sulfate was hydrolyzed, showed the presence of tritium in all three carbon positions, the smallest amount being located at C-2. In the 13.8 M acid, the heating of the reaction mixture at 50 ± 2°C for 30 hr to effect the ester hydrolysis also led to the formation of some 2-propanol. After heating 1-propanol-1-t at 50 ± 2°C for 30 hr, the recovered 1-propanol also showed some rearrangement of the t-label to C-2 and C-3. From the experiments which did not involve any complication arising from subsequent reactions of the 1-propanol, the average t distribution in the 1-propanol derived from solvolysis of cyclopropane in H_2SO_4-t was about 37, 26, and 37%, respectively, at C-1, C-2, and C-3. The mechanistic pathways involving protonated cyclopropane intermediates and the possible influence of isotope effects on the observed isotopic distributions are discussed. (auth)

37730 STEREOCHEMISTRY OF CHLORIDE EXCHANGE IN DESYL CHLORIDE. Lutz, R. P. (Univ. of Illinois, Chicago). J. Amer. Chem. Soc., 90: 3788-90(July 3, 1968).

Desyl chloride is one of a number of α-halo ketones which, with some nucleophiles, gives epoxide products derived from attack of the nucleophile at the carbonyl group followed by intramolecular displacement of halide. To test the hypothesis that the high reactivity of α-halocarbonyl compounds in bimolecular nucleophilic displacements may be due to the operation of a mechanism involving epoxide intermediates, the stereochemistry of chloride exchange in desyl chloride was determined by comparing the rates of racemization and exchange in acetone solutions of Li^{36}Cl. The reaction was found to proceed with inversion, a result which is inconsistent with an epoxide intermediate and which establishes the usual Sn2 stereochemistry in this case. (auth)

37731 OXYGEN EXCHANGE BETWEEN TRIS(OXALATO) RHODATE(III) ION AND SOLVENT WATER. EXCHANGE OF OUTER AND INNER OXYGENS. Damrauer, Lenore; Milburn, Ronald M. (Boston Univ.). J. Amer. Chem. Soc., 90: 3884-5 (July 3, 1968).

It was found that $Rh(C_2O_4)_3^{3-}$ in acidic media exchanges one half of its oxygen significantly more rapidly than the other half. Kinetic data on acid-catalyzed oxygen exchange, racemization, and aquation for $Rh(C_2O_4)_3^{3-}$ are tabulated. The oxygen exchange at ionic strength 0.54 is represented graphically for the outer oxygens at 25.1°C and the inner oxygens at 45.0°C. (D.H.M.)

37732 REACTIONS OF METHYL RADICALS WITH AROMATIC HYDROCARBONS. EFFECT OF CONFORMATION AND CARBON–HYDROGEN ORIENTATION UPON THE RATE, THE ACTIVATION ENERGY, AND THE A FACTOR. Eachus, A. E.; Meyer, J. A.; Pearson, J.; Szwarc, M. (Syracuse Univ., N. Y.). J. Amer. Chem. Soc., 90: 3646-50(July 3, 1968).

Competition between RH + $CH_3\cdot \rightarrow R\cdot + CH_4$ (k_1), and $C_6H_5CH_3$ + $CH_3\cdot \rightarrow C_6H_5CH_2\cdot + CH_4$ (k_T) was investigated in the liquid phase over a temperature range 0 to 95°C. Methyl radicals were produced by the photolysis of azomethane, and tritiated toluene, $C_6H_5CH_2T$, was used to distinguish between the products of the reaction of RH and toluene. The following compounds were studied: o-, m-, and p-xylenes, mesitylene, ethylbenzene, 1,2-diphenylethane, indan, tetralin, cumene, p-t-butylcumene, cyclohexylbenzene, diphenylmethane, and triphenylmethane. The results show that the reactivity is governed primarily by the nature of the carbon–hydrogen bond: tertiary > secondary > primary. Within each series the ratio A_1/A_T (per active H atom) remains essentially constant if the effect of conformation is taken into account. Changes in reactivity are caused by changes in the respective activation energies, again corrected for the effect of conformation which introduces an additional term, Δ, in the observed activation energy. It was found that the abstraction of a tritium atom requires 2.7 kcal/mole higher activation energy than the abstraction of hydrogen. (auth)

37733 KINETICS AND OXYGEN ISOTOPIC FRACTIONATION IN THE REACTIONS OF THE ISOMERIC CHLOROAQUOTETRAAMMINECHROMIUM(III) IONS WITH CHROMIUM(II). DeChant, Sr. M. J.; Hunt, J. B. (Catholic Univ. of America, Washington, D. C.). J. Amer. Chem. Soc., 90: 3695-9(July 3, 1968).

The total loss of ammonia from cis- and trans-chloroaquotetraamminechromium(III) ions is catalyzed by chromium(II), both isomers yielding the chloropentaaquochromium(III) ion as the aquation product. Both reactions obey rate laws of the form rate = $k[Cr(II)][Cr(NH_3)_4(OH_2)Cl^{2+}]$, where k = 1.16 M^{-1} sec^{-1} at 25°C and E_a = 10.3 kcal/mole for the trans isomer, and k = 1.14 × 10^{-1} sec^{-1} at 25°C and E_a = 11.2 kcal/mole for the cis isomer in perchlorate media at μ = 1.0. The reaction rate of the trans isomer is increased to a greater extent by both an increase in ionic strength and the addition of chloride ion than is the cis isomer. The fractionation of ^{18}O compared to ^{16}O in the aquo ligand was measured for the reactions of both isomers with chromium(II). The kinetic fractionation factors, $K_{^{18}O}/K_{^{16}O}$, are 1.017 for the trans isomer and 1.007 for the cis isomer. These results are interpreted to mean that the chromium(III) complex must undergo tetragonal distortion in the formation of the activated complex. (auth)

37734 BENZENE PHOTOSENSITIZATION AND DIRECT PHOTOLYSIS OF CYCLOBUTANONE AND CYCLOBUTANONE-2-t IN THE GAS PHASE. Denschlag, H. O.; Lee, Edward K. C. (Univ. of California, Irvine). J. Amer. Chem. Soc., 90: 3628-38(July 3, 1968).

The fluorescence of the $^1B_{2u}$-state benzene is quenched by cyclobutanone with a quenching cross section ($\pi\sigma^2$) of 4 Å^2, and this singlet energy transfer produces an excited singlet cyclobutanone which subsequently decomposes to yield primarily

ethylene (plus ketene). The $^3B_{1u}$-state benzene transfers its electronic energy to cyclobutanone with a quenching cross section ($\pi\sigma^2$) of 1 Å^2 to produce an intermediate which subsequently decomposes to yield a vibrationally excited cyclopropane (plus CO). The yield of cyclopropane is lowered by the addition of cis-2-butene which is a quencher of the triplet benzene, and therefore it is proposed that cyclopropane is a characteristic decomposition product of a triplet cyclobutanone. Sensitization quantum yields were determined, and they are near unity. The comparison of the decomposition product distribution in the benzene-photosensitized samples with that observed at varying excitation energies (wavelength) in the direct photolysis of cyclobutanone indicates that, on the average, about 96 kcal/mole of excitation energy is delivered to cyclobutanone in the singlet energy transfer while about 80 to 85 kcal/mole of excitation energy is delivered to cyclobutanone in the triplet energy transfer. (auth)

37735 THE INFRARED SPECTRA OF LIQUID H_2O AND D_2O IN THE 1000 TO 250 CM^{-1} RANGE. Simon, Martha Nichols. Ithaca, N. Y., Cornell Univ., 1968. 109p.

Thesis.

By using the attenuated total reflectance technique, the infrared spectra of liquid H_2O and D_2O (expressed as absorption index, k, vs frequency, ν) were obtained in the intermolecular vibrational frequency region from 1200 to 250 cm^{-1}, over the temperature range of 7 to 55°C. A theoretical analysis of the spectra was carried out by considering liquid water to be a mixture of molecules having four, three, two, one, and zero hydrogen bonds, respectively. By performing normal coordinate analyses on each of the hydrogn-bonded species, with force constants being derived from the known force constants for ice, the intermolecular vibration frequencies were obtained. It was possible to fit the observed spectra of H_2O and D_2O and their temperature dependences, using the computed frequencies, together with theoretical values of the mole fractions (and their temperature dependences) of the various hydrogen-bonded species. Thus, a discrete-species model of liquid water can lead to rather continuous-appearing spectra; there is no necessity of invoking a "continuum" theory of water structure to account for the spectra. (Disser. Abstr.)

37736 INVESTIGATION OF THE KINETICS OF THE ISOTOPIC EXCHANGE OF CO_2 ON THE SURFACE OF CHROMIC OXIDE. Amerikov, V. G.; Kasatkina, L. A.; Popova, G. Yu. (Moscow Chemical-Technological Inst.). Kinet. Kataliz, 9: 429-32(Mar.-Apr. 1968). (In Russian).

The kinetics of the reaction $C^{16}O_2 + C^{18}O_2 = 2C^{16}O^{18}O$ on the surface of different samples of treated chromic oxide were investigated in the temperature range from −78° to +350°C at pressures from 10 to 175 mm Hg. The activity of Cr_2O_3 exposed to CO_2 or O_2 is less than the activity of chromic oxide processed in vacuum. The activation energy of the exchange was 4.7 and 1.8 kcal/mole, respectively. The rate of the homomolecular exchange in the CO_2 molecule was greater than the rate of exchange of oxygen isotopes between Cr_2O_3 and CO_2. It was suggested that the isotopic exchange of oxygen in the CO_2 molecule on chromic oxide proceeds by a bimolecular mechanism. (tr-auth)

37737 INVESTIGATION OF THE REACTION CAPACITY OF OXYGEN OXIDE IN REDUCING MEDIUM BY THE METHOD OF ISOTOPIC EXCHANGE. Rachkovskii, E. E.; Boreskov, G. K. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Kataliz, 9: 289-94(Mar.-Apr. 1968). (In Russian).

The catalytic activity of a series of oxides of the transition metals of period IV and chromites was investigated in relation to the deuterium exchange reaction between hydrogen and water vapor. Comparison with the activity of the same catalysts in reactions of the conversion of carbon monoxide with water vapor indicated the absence of a complete correlation between the activities in relation to both reactions. The possible reason for the non-correlation is proposed. (tr-auth)

37738 TEMPERATURE DEPENDENCE OF FLUORESCENCE DECAY OF URANYL SALTS. Pant, D. D.; Pant, H. C.; Pande, D. N. (Government Coll., Naini Tal, India). Indian J. Pure Appl. Phys., 6: 122-5(Mar. 1968).

The lifetimes and relative quantum yields at various temperatures were measured for several uranyl salts. Using the simple Mott and Seitz approach for deactivation processes, the values of ΔE (activation energy) and A (pre-exponential factor) were calculated. A low frequency of nearly 90 cm^{-1} and another of nearly 2780 cm^{-1} are shown to take part in nonradiative dissipation. Individual peculiarities are pointed out. The sulfates have a distinctly higher value of ΔE. Discontinuities in the lifetimes with temperature are observed in frozen uranyl nitrate solution at about 220°K and uranyl potassium sulfate at about 380°K due to phase transformations. No changes on deuteration in the nonradiative temperature-dependent constant are observed. (auth)

37739 STUDY OF COMPLEX FORMATION OF ELEMENTS WITH REAGENTS OF THE ARSENAZO III GROUP BY A SPECTROPHOTOMETRIC AND A POTENTIOMETRIC METHODS. Savvin, S. B.; Propistsova, R. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 813-20 (June 1968). (In Russian).

A study was made of the possibilities of one of the modifications of the potentiometric titration method which permits the simultaneous establishment of the complex composition (stoichiometric coefficients of the reaction) and the number of protons liberated during the reaction. During the complex formation of Arsenazo III with La and UO_2^{2+} only one functional-analytical group of the reagent molecule takes part in complex formation. Correspondingly, two protons are liberated for each reagent molecule. On the complex formation of Arsenazo III (and other 2,7-bisazo derivatives of chromotropic acid) with Cu^{2+}, VO^{2+}, and Pd^{2+} both of the functional-analytical groups can participate in complex formation. Correspondingly, at a molar ratio of 2:1 (Me_2R) four protons are liberated for each reagent molecule. (auth)

37740 KINETIC ISOTOPE EFFECTS IN THE HYDROGEN ELECTRODE REACTION. McIntyre, J. D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Salomon, M. J. Phys. Chem., 72: 2431-4(July 1968).

Partition function ratios for hydrogen and deuterium gases and the lyonium species $L_2O(l)$, L_3O^+, and OL^- (where L = H or D) were reevaluated from recent spectroscopic and thermodynamic measurements. These values may be employed in predicting deuterium isotope effects in electrochemical reactions, in estimating the energies of transfer of anions between protium and deuterium oxide solutions, and in establishing an electrode-potential scale for heavy-water electrolytes. The results of measurements of the rate of hydrogen evolution on mercury electrodes in electrolytes of pure and mixed isotopic (H−D) composition are compared and are shown to be in accord with a mechanism involving a rate-determining proton-discharge step. (auth)

37741 GRAVIMETRIC ADSORPTION STUDIES OF THORIUM OXIDE. III. ADSORPTION OF WATER ON POROUS AND NONPOROUS SAMPLES. Holmes, H. F.; Fuller, E. L. Jr.; Secoy, C. H. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 72: 2293-2300(July 1968).

The absorption of water at 25.00°C on two contrasting samples of thorium oxide was investigated using a sensitive vacuum microbalance. Although the specific surface areas of the two samples were approximately equal (about 6 m^2/g), their porosities were markedly different. Adsorption−desorption isotherms for water on one of the samples showed hysteresis due to capillary condensation in pores down to, and including, two molecular diameters in size. In contrast, no evidence of capillary condensation was found with the second sample. Outgassing studies on both samples showed that temperatures as high as 1000°, in vacuo, were required to dehydrate the surfaces completely. Both samples exhibited irreversible retention of water in amounts much greater than that required for complete hydroxylation of the bare surface. Application of the BET equation indicated that the amount of water required to form a physically adsorbed monolayer on top of the irreversibly adsorbed water was drastically different for the two samples. The results are interpreted in terms of hydration of the surface hydroxyl groups. Differences in the statistical monolayer capacities of the two samples are attributed to the spatial arrangement of the hydrating water molecules on the 100 and 111 crystal faces. (auth)

37742 ISOTOPE EFFECT ON THE VAPOR PRESSURES OF H_2O–C_2H_5OH AND D_2O–C_2H_5OD MIXTURES. Linderstroem-Lang, C. U.; Vaslow, Fred (Danish Atomic Energy Commission, Risoe, Denmark). J. Phys. Chem., 72: 2645-50(July 1968).

The vapor pressure isotope effect in the liquid composition range 0 to 80 mol % ethanol was studied by a static method that permits measurements to be obtained that are accurate to about 0.01 mm relative to the vapor pressure of water. The measuring system consists of a silicon−oil manometer, read with a long-range cathetometer. Small amounts of noncondensable gases in the vapor phase are swept from the sample vessel with sample vapor distilling into a CO_2 trap, and their contribution to the total vapor pressure is estimated on a Pirani gauge. The activity coefficients of the two components in both isotopic systems are calculated from the total-pressure data (by three different methods) and are checked by vapor-composition determinations. The isotope effects in terms of the logarithm of the activity-coefficient ratios show interesting trends (crossover phenomena) which are discussed on the basis of current ideas of the structure of alcohol−water mixtures. (auth)

37743 KINETIC STUDY OF THE SYSTEM $^{237}Np(V)$.Cr(III)–$^{239}Np(V)$. Sullivan, James C.; Burkhart, Mary J. (Argonne

National Lab., Ill.). J. Phys. Chem., 72: 2675-7(July 1968).

The exchange reaction $^{239}Np(V) + Np(V) \cdot Cr(III) \rightarrow Np(V) + {}^{239}Np(V) \cdot Cr(III)$ was studied. Attempts to correlate the data in terms of dissociation plus exchange using equations previously developed demonstrated that the only change in the specific β^- activity of the Np(V) with time was due to dissociation of the complex. The data can, therefore, be used to determine a value for the specific rate constants k of the reaction $Np(V) \cdot Cr(III) \xrightarrow{k} Np(V) + Cr(H_2O)_6^{3+}$. Values for the first-order constants for the equation are tabulated for 25, 35, and 50°C. At 50°C in 1.00 M $HClO_4$ the average value of the rate parameter was $(7.50 \pm 0.20) \times 10^{-5}$ sec^{-1} and at 25°C was $(2.08 \pm 0.07) \times 10^{-6}$ sec^{-1}. A value for the experimental activation energy E = 25.8 ± 0.3 kcal/mol was computed from the data at 2.00 M $HClO_4$. (D.H.M.)

37744 KINETIC ISOTOPE EFFECTS: APPROXIMATE CALCULATIONS. Chang, Paul C.; Gatz, Carole R. (Portland State Coll., Oreg.). J. Phys. Chem., 72: 2602-4(July 1968).

Treating the activated complex for unimolecular dissociation as uncoupled fragments simplifies the calculation of transition-state frequencies in the quasi-equilibrium-theory formulation of an isotopic rate-constant ratio. The general method is applied to the specific case of the intramolecular kinetic isotope effect in decarboxylation of malonic acid. The fragment models are further simplified by means of the "cutoff" approximation of Stern and Wolfsberg. These model calculations are in agreement with the presently available experimental results. Applicability to reactions involving simultaneous multiple bond rupture or formation is noted. (auth)

37745 SOME REMARKS ABOUT 5f → 6d AND CHARGE TRANSFER TRANSITIONS IN URANIUM(IV) AND PLUTONIUM(IV) COMPLEXES. Poturaj-Gutniak, S.; Taube, M. (Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 30: 1005-12(May 1968).

Absorption spectra of uranium(IV) and plutonium(IV) complexes with chloride and oxygen-containing ligands in the range 220 to 400 nm were determined. Absorption bands are ascribed to $5f^n \rightarrow 5f^{n-1}6d$ and charge transfer transitions. Relationships were established between electronegativity of the ligand and the number and position of $5f^n \rightarrow 5f^{n-1}6d$ and charge transfer transitions for the complexes. (auth) (UK)

37746 EQUILIBRIUM PHASE DIAGRAM OF THE LITHIUM FLUORIDE–BERYLLIUM FLUORIDE–ZIRCONIUM FLUORIDE SYSTEM. Thoma, R. E.; Insley, H.; Friedman, H. A.; Hebert, G. M. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 27: 166-80(Aug. 1968).

The equilibrium phase diagram for the $LiF-BeF_2-ZrF_4$ system was established throughout all temperature intervals (approximately 350 to 1000°C) in which liquid-solid phase transitions occur. The liquidus surface of the $LiF-BeF_2-ZrF_4$ system comprises eight primary phase fields, those of the three components, and of five complex compounds: Li_2BeF_4, Li_3ZrF_7, Li_2ZrF_6, $Li_3Zr_4F_{19}$, and $Li_6BeF_4ZrF_8$. The associated phase reactions result in the occurrence of nine invariant equilibrium points, at temperatures which range from 355 to 540°C. A region of liquid-liquid immiscibility, rare in fluoride systems, was observed with BeF_2-rich mixtures at temperatures from the $LiF-BeF_2-ZrF_4$ liquidus to an upper critical solution temperature of 955°C. Composition-temperature relationships within this region were established by use of a high-temperature centrifuge. (auth)

37747 INTERACTIONS OF NITROGEN WITH Mo AND THE REACTION $^{28}N_2 + {}^{30}N_2 \rightleftharpoons 2\,{}^{29}N_2$ CATALYZED BY Mo AND OBSERVED BY MASS SPECTROMETER. Moore, George E.; Unterwald, F. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 48: 5393-5408(June 15, 1968).

Interactions between N_2 and a Mo catalyst, believed significant for synthesis of ammonia are described. These interactions were sorption, desorption, and isotopic exchange using the same ribbon filament catalyst S as for exchange in hydrogen and for ammonia synthesis; it was previously used for thermal dissociation of H_2. Nitrogen dissolves in S at all temperatures significant for NH_3 synthesis. Below 1000°K it also forms the nitride. $^{30}N_2$ was used where possible to avoid mass ambiguity with CO, ^{14}N and ^{15}N compete in sorption, both on the surface and interior. During the exchange, the three molecular nitrogens desorb from S in equilibrated abundances at all accessible temperatures (T's) and covers. However, accessible T is limited on the low side because nitrogen binds so tightly to Mo that puffs adequate for measurement will not desorb below 1000°K and CO, which was not resolved from $^{28}N_2$, is less tightly bound; it causes significant error in measuring convenient sized $^{29}N_2$ puffs, unless T during sorption is sufficiently high to eliminate CO. Even more clearly than for exchange in hydrogen, nitrogen exchange by Mo brings into serious question tacit assumptions in much recent published work on adsorption and catalysis. These assumptions consider that all interactions occur on the surface of the catalyst (or adsorbent). For N_2 exchange by Mo, diffusion into S was fully as decisive as for hydrogen exchange. Most published experiments employ an ionization gauge to measure pressure changes and also assume, without chemical identification, that pressure changes observed are caused entirely by gas intentionally admitted. Neglect of chemical identification may be responsible for failure to observe volume diffusion effects in recent literature. The measured probability for sorption per collision of N_2 on Mo was 0.14 ± 0.04, which is considerably below values previously published. (auth)

37748 PHASE DIAGRAMS OF H_2O AND D_2O AT HIGH PRESSURES. Pistorius, Carl W. F. T.; Rapoport, Eliezer; Clark, J. B. (South African Council for Scientific and Industrial Research, Pretoria). J. Chem. Phys., 48: 5509-14(June 15, 1968).

The VIII/VII phase boundaries of solid H_2O and D_2O were studied by means of differential thermal analysis. The thermal hysteresis of the transition decreases with increasing pressure, but the presumed equilibrium temperatures are independent of pressure to 40 kbar. The transition is of the first order, and the average transition temperature is –3°C in both cases. The ice VI/VII transition pressure at 25°C is 21.39 ± 0.05 kbar, in good agreement with other recent studies, but considerably lower than Bridgman's value. The heavy ice VI/VII and VI/VIII transition lines are located ~1.4 kbar below the ice VI/VII and VI/VIII transition lines. The heavy ice VI/VIII transition at 25°C occurs at 19.90 ± 0.07 kbar. Bridgman's melting curves of ice VI and ice VII are shown to be correct. The melting curve of heavy ice VI is ~2°C above that of ice VI, but the heavy-ice VI/VII/liquid triple point is located at 78°C, 20.6 kbar as compared with 81.6°C, 21.97 kbar for H_2O. The melting curve of heavy ice VII appears to have a stronger curvature than the melting curve of ice VII. (auth)

37749 ELECTRON SPIN RESONANCE OF THE MONO-DEUTEROTROPENYL RADICAL. EFFECT OF THE DEUTERIUM SUBSTITUENT. Volland, Walter V.; Vincow, Gershon (Univ. of Washington, Seattle). J. Chem. Phys., 48: 5589-95(June 15, 1968).

Monodeuterotropenyl radical, $C_7H_6D\cdot$, is generated by thermal cleavage of liquid, x,x′-dideuterobitropenyl (x,x′-dideutero-bi-2,4,6-cycloheptatrien-1-yl) and is investigated by means of electron spin resonance (ESR) spectroscopy. An assessment of the effect of the deuterium substituent on the vibronic near degeneracy of this radical was attempted. The ESR spectrum of $C_7H_6D\cdot$ appears to correspond to hyperfine interaction with six equivalent protons and one deuteron. The expected inequivalence of the proton splittings is less than the linewidth. From a detailed analysis of the magnitude of the linewidth, an upper limit of 25 cal/mole is estimated for the energy separation between the nearly degenerate vibronic levels of $C_7H_6D\cdot$. This estimate is compared with the energy splitting of $C_6H_5D^-$ and is correlated with the prediction of the resonance integral perturbation model for the effect of a deuterium substituent [J. Am. Chem. Soc., 87: 5260 (1965)]. The proton and deuteron hyperfine splittings are measured as a function of temperature (130 ≤ t ≤ 186°C). The temperature dependence of the proton splitting agrees closely with that of $C_7H_7\cdot$. The ratio a^H/a^D decreases with increasing temperature and is most likely greater than 6.514. The g value, 2.00266, is in agreement with that of $C_7H_7\cdot$. A small positive temperature coefficient is indicated by the g-value data. (auth)

37750 CHEMISTRY OF n-$B_{18}H_{22}$ AND i-$B_{18}H_{22}$. Olsen, Frederic P.; Vasavada, Ravindra C.; Hawthorne, M. Frederick (Univ. of California, Riverside). J. Amer. Chem. Soc., 90: 3946-51(July 17, 1968).

The isomeric hydrides n-$B_{18}H_{22}$ and i-$B_{18}H_{22}$ were examined with regard to their chemical reactivities toward bases, nucleophiles, electrophiles, and electron addition. Both hydrides are strong diprotic acids with first and second pK_a's of approximately –1 and +8, respectively. Treatment of n-$B_{18}H_{22}$ with I_2 in ethanol apparently produced $B_{18}H_{21}I$. Reduction of n- and i-$B_{18}H_{22}$ with sodium amalgam afforded isomeric $B_{18}H_{23}^-$ ions. Acid-catalyzed deuterium exchange of both $B_{18}H_{22}$ isomers led to the introduction of six deuterium atoms per mole. Base-catalyzed deuterium exchange resulted in the introduction of six deuterium atoms per mole of hydride with both isomers of $B_{18}H_{22}$. Prolonged treatment of n-$B_{18}H_{22}$ with aqueous base resulted in the formation of $B_{12}H_{12}^{2-}$ while similar treatment of i-$B_{18}H_{22}$ apparently produced borate salts. Reaction of n- and i-$B_{18}H_{22}$ with n-butyllithium produced the corresponding $B_{18}H_{21}^{3-}$ ions. (auth)

37751 GENERAL ACID CATALYSIS OF ACETAL HYDROLYSIS. THE HYDROLYSIS OF 2-ARYLOXYTETRAHYDROPYRANS. Fife, Thomas H.; Jao, L. K. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc., 90: 4081-5(July 17, 1968).

The rates of acid-catalyzed hydrolysis of a series of 2-alkoxy-

and 2-aryloxytetrahydropyrans were measured in 50% dioxane–H_2O. The value of ρ determined for hydrolysis of 2-(para-substituted phenoxy)tetrahydropyrans was –0.92. The D_2O solvent isotope effect (k_{D_2O}/k_{H_2O}) progressively decreased as electron withdrawal in the leaving group became greater: from 2.82 for 2-ethoxytetrahydropyran to 1.33 for 2-(p-nitrophenoxy)-tetrahydropyran. The value of ΔS^* likewise became considerably more negative: +7.9 eu in the case of the ethoxy derivative and –7.6 eu in the case of 2-(p-nitrophenoxy)tetrahydropyran. Thus, it is likely that, as C–O bond breaking becomes easier and at the same time basicity of the acetal decreases, the solvent becomes more involved in the critical transition state with the most probable mechanism for the aryloxy derivatives involving partially rate-determining protonation by hydronium ion. General acid catalysis by formate buffers was also observed for hydrolysis of 2-(p-nitrophenoxy)tetrahydropyran and 2-(p-chlorophenoxy)-tetahydropyran. (auth)

37752 RELATIONSHIP BETWEEN ISOTOPE EFFECTS AND REACTIVITY. Kresge, A. J.; Sagatys, D. S.; Chen, H. L. (Illinois Inst. of Tech., Chicago). J. Amer. Chem. Soc., 90: 4174-5 (July 17, 1968).

Isotope effects, $k_{H_3O^+}/k_{D_3O^+}$ were measured in the hydrolysis of 14 vinyl ethers in aqueous solutions at 25°. The data seem to indicate that kinetic isotope effects can show the theoretically expected dependence on transition-state structure when the latter is measured by relative reactivity provided that comparison is restricted to a single reaction type. (J.G.B.)

37753 STUDIES OF TUBES WITH ThO_2 AND Y_2O_3 OXIDE COATINGS ON WR-ALLOY CATHODE BASE. Moshkin, I. A. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz-Mat. Nauk, No. 1, 34-6(1968). (In Russian).

Experimental studies of ThO_2 and Y_2O_3 coatings on WR-2 (tungsten cathode base) showed that the most efficient operating temperature of such cathode tubes is from 1700 to 1750°K, with the possibility of continuous performance for 2500 or more hours. (R.V.J.)

37754 REACTION OF $H_2 + D_2 \rightleftharpoons 2HD$ CATALYZED BY MOLYBDENUM AND OBSERVED BY MASS SPECTROMETER. Moore, George E.; Unterwald, F. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 48: 5378-92(June 15, 1968).

H_2-D_2 exchange reaction catalyzed by Mo ribbon is discussed. Publications for the H_2-D_2 exchange show a trend toward the expected equilibrium, but evaluation of catalytic effectiveness usually involved many sorptions of each reactant molecule with the heated catalyst. The technique used permits evaluation resulting from a single sorption interaction and shows that sorbed molecules leave the catalyst S at relative abundances agreeing with the equilibrium constant K of the exchange reaction. This equilibration during a single interaction occurs throughout the experimentally accessible temperature range 335°K to above 1000°K and for covers between 0.05 and approximately a complete monolayer. Contamination by nitrogen and by CO does not affect equilibration. Results imply that the catalyst splits the reactant molecules at least intermittently and may suggest atomic, rather than molecular sorption. However, published experiments warn against complete acceptance of atomic sorption. If exchange reactions involve only the catalyst surface, as generally thought, relative departure rates for H_2, D_2, and HD molecules would satisfy the usual conservation relation calculated from incidence rates from the gas phase onto the catalyst. This relation is independent of K but, with K, would completely specify relative desorption rates of the three molecular forms of hydrogen. Experimentally, only K is satisfied. Desorption rates are not directly related to incidence rates and are only understood if much of the hydrogen and deuterium participating in exchange comes from a phase dissolved in the catalyst, rather than from an adsorbed layer. This and other results suggest that H_2-D_2 exchange is related more critically to the volume of the catalyst than to its surface. If such results occur for other catalysts and other reactions, widely accepted models for catalysis must be reconsidered. (auth)

37755 COMPLEX COMPOUNDS OF TRANSURANIDES. Gel'man, A. D.; Moskvin, A. I.; Zaitsev, L. M.; Mefod'eva, M. P. New York, Daniel Davey and Co., Inc., 1967. 160p. $10.25. (IPST-Cat.-2185).

Translated from Russian by J. Schmorak, Israel Program for Scientific Translations, Jerusalem.

An abstract of the original Russian edition appeared as NSA 16: 7575. (D.H.M.)

37756 SPURIOUS ISOTOPE EFFECTS IN ENZYMATIC REACTIONS WITH TRITIUM-LABELED SUBSTRATES. Oldham, K. G. (Radiochemical Centre, Amersham, Eng.). J. Label. Compounds, 4: 127-33(Apr.-June 1968).

Tritium labeled substrates are commonly used in enzyme assays on account of their high specific activity, cheapness, and availability. Because of certain special effects occurring with tritium labeled compounds, isotope effects may erroneously be inferred from rate measurements using these compounds. These special effects, and recommended methods of detecting and eliminating them, are discussed. This includes apparent low rates due to labilization of tritium, apparent false rates due to uncertainty about the specific activity of the substrate, intramolecular migration of tritium, and errors resulting from the use of specifically labeled substrates in which the position of labeling is not exactly as specified. (P.C.H.)

37757 MECHANISMS AND KINETICS OF THE DISSOLUTION OF URANIUM(IV) OXIDE IN SULFURIC ACID SOLUTION IN THE PRESENCE OF IRON(III) IONS. Sklibova-Klabolova, J.; Neumann, L. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun., 33: 1678-86(June 1968). (In German).

A relation between the linear rate of solution of UO_2, the reduction–oxidation potential of the solution, and the rate of mixing was investigated. The dissolution of UO_2 in sulfuric acid solutions under oxidation by Fe^{3+} ions was controlled by an oxidized intermediate compound originating by equilibrium reactions between UO_2 and Fe^{3+} on the surface of the solid phase. (tr-auth)

37758 PREPARATION AND PROPERTIES OF THE ASTATOACETIC ACID. Samson, G.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 9: 53-4(1968).

Astatoacetic acid was prepared by the exchange reaction of At^- containing I^- as a carrier with an acid ICH_2COOH solution. The fact that the astatine in the sample was actually present in the form of astatoacetic acid was proved in two ways. If the acids were run through a Dowex 1 × 8 column, the activity was retained on the ion exchanger. It could be eluted with 0.5 N $NaNO_3$, in which case the astatine peak, containing all the At activity, followed very closely after the peak of ICH_2COOH (with $R \approx 0.2$). (P.C.H.)

37759 ENERGY LEVELS AND VIBRONIC INTENSITIES IN CRYSTALS HAVING U^{4+} HALIDE COMPLEXES. Schreiber, Charles Leonard. Los Angeles, Univ. of California, 1967. 196p. Thesis.

A study was made of the vibronic absorption spectra of $[(CH_3)_4N]_2UCl_6$, Cs_2UCl_6, and Cs_2UBr_6 salts. The similarities observed in these spectra both in the intensities and in the transition energies are shown to be based on the existence of a tightly bonded UX_6^{2-} halide complex that has a large "crystal field" with octahedral O_h symmetry interacting with the uranium ion. A diagonalization of the Hamiltonian containing the electrostatic, spin-orbit, and crystal field interactions within a basis of states from the $5f^2$ configuration of the U^{4+} free ion is made and the eigenvalue spectrum for the low-energy electronic states (within 4 eV of the ground state) is fitted to within an average deviation of 130 cm^{-1}. The vibronic interaction V_{eV} between the electronic and vibrational states of the crystal is approximated by a model involving the "odd" vibrational modes of the UX_6^{2-} complex. The intermediate states mixed into the $5f^2$ states by this vibronic interaction are used to obtain electric dipole vibronic transitions. Several selection rules which limit the useful intermediate states and the allowed vibronic transitions are discussed. A closure is made over the intermediate states to allow the oscillator strength of a vibronic band associated with either the $^3\Gamma_{4u}$ or $^3\Gamma_{5u}$ vibrations of the complex to be expressed as $f = [\sum_\alpha R_\alpha(u_i|T^\alpha|u_j)]^2$, where T^α is a tensor operator connecting the ground and excited $5f^2$ states and the summation runs over the six values 1 through 6 when a $^3\Gamma_u$ vibrational mode is used in the transition and over the four values 7 through 10 when a $^3\Gamma_{8u}$ mode is involved. Sets of the R_α coefficients are found which provide a fair fit with the experimental intensities of the $[(CH_3)_4N]_2UCl_6$ and Cs_2UBr_6 salts. The inherent differences between this intensity calculation and the work done on the lanthanide salts are discussed. (Disser. Abstr.)

37760 TRANSURANIUM PROGRAM. Burch, W. D. pp 11-18 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The history, method of production, properties, and uses of the transuranium elements are reviewed. (D.H.M.)

37761 CRYSTAL CHEMISTRY OF RADIUM. I. THE HALOGENIDES OF RADIUM. Weigel, F.; Trinkl, A. (Univ., Munich. Technische Hochschule, Munich). Radiochim. Acta, 9: No. 1, 36-41(May 1968). (In German).

Microscale preparation and x-ray diffraction studies on anhydrous radium halides are reported. The radium halides are isomorphous with the corresponding barium halides. The ionic radius of Ra^{2+} was obtained by extrapolation from the experimental unit cell volumes of the fluorides of Ca, Sr, and Ba. Based on Zachariasen's radii, a value of 1.36 Å, based on Goldschmidt's radii, a value of 1.53 Å is obtained, in good agreement with the theoretical values. (auth)

37762 EFFECT OF SPECIFIC RADIOACTIVITY OF ^{124}Sb ISOTOPE ON THE ELECTRICAL DEPOSITION OF ANTIMONY. Arakelyan, V. S.; Spitsyn, Vikt. I.; Uvarov, L. A. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 173: 1367-9(Apr. 1967). (In Russian).

A total of 100 mg of metallic antimony (Sb) was dissolved in a $HF-HNO_3$ (18:1) mixture at room temperature. A total of 200 to 300 mg of citric acid, ~1 mg $Bi(NO_3)_3$, and ~0.03 mg of thiourea were added, and Sb electrodeposition was carried out at a volume of 400 to 500 ml at room temperature on copper disks (14 × 5 × 2.5 mm). A black coarse deposit was obtained at a current density of 0.02 a/dm² from nonradioactive solutions. Then three solutions were prepared with a metal concentration of 0.2 g/l, but with three different specific radioactivities of 250, 25, and 2.5 mCi of ^{124}Sb per gram. Electrolysis of these solutions was carried out simultaneously in three cells connected in series. The results of the experiments showed that an increase in the specific activity of antimony led to a change from a dense adherent bright deposit to a dark coarse deposit. Compact deposits were also obtained at small current densities. It appeared that radioactivity increased the electrochemical activity of parts of the surface, where metal was more likely to deposit as a coarse precipitate. (TTT)

37763 THERMODYNAMIC STABILITY OF URANIUM HEXAFLUORIDE. Tumanov, Yu. N. Zh. Neorg. Khim., 13: 1488-93 (June 1968). (In Russian).

Since UF_6 disintegrates to UF_4 during heating to temperatures of 1400 to 2000°K and pressures of 0.1 to 0.001 atm, the thermodynamic functions of UF_4 can be used to determine the thermodynamic stability of UF_6. An empirical method for the calculation of the thermodynamic functions of gaseous UF_4 is proposed. It is based on the two following assumptions: the total of the oscillation and rotational functions of the tetrafluoride does not depend on the choice of the quantum-mechanical model of the number potentially possible for the given molecule; and the length of the $U^{IV}-F$ bond is noticeably smaller (±0.02 Å) than the length of the $U^{VI}-F$ bond. Using SF_4 as an example, an evaluation was made of the errors in the thermodynamic calculation of the functions of $(UF_4)_{gas}$ using the model of normal tetrahedron. In the approximation of the model of the rigid rotator-harmonic oscillator, the values of the standard entropy and reduced thermodynamic potential of the gaseous UF_4 were calculated in the temperature interval from 298.16 to 2000°K. The equilibrium constants of the thermal cracking of $(UF_4)_{gas}$ were calculated and the percent yields of the gaseous tetrafluoride in the equilibrium mixture were evaluated. (tr-auth)

37764 INVESTIGATION OF THE COMPLEX FORMATE COMPOUNDS OF THORIUM BY THE METHOD OF INFRARED SPECTROSCOPY. Petrov, K. I.; Molodkin, A. K.; Saralidze, O. D.; Ivanova, O. M. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim., 13: 1716-19(June 1968). (In Russian).

The infrared absorption spectra (400 to 3800 cm^{-1}) of the formate compounds of thorium $MeTh(HCOO)_5$ ($Me = K^+$, Rb^+, Cs^+), $Cs_2Th(HCOO)_6$, $BaTh(HCOO)_6 \cdot 2H_2O$, $BaTh(HCOO)_6$, and $Me_4Th(HCOO)_8$ ($Me = Na^+$ and Rb^+) were obtained. It was shown that, in the compounds studied, the formate groups were coordinated with thorium. The complete similarity of the spectra of $BaTh(HCOO)_6 \cdot 2H_2O$ and $BaTh(HCOO)_6$ in the region of the oscillation of the formate groups is shown by the like structure of these compounds. The infrared absorption spectra do not give sufficient data for opinions on the character of the coordination of the formate groups (mono- or bidentate) with the thorium in the formate complex compounds. (tr-auth)

37765 STUDY OF THE ADSORPTION OF RADON DAUGHTERS TO SOME SUB-MICRON POLYDISPERSE AEROSOLS AND TO SOME NATURAL AEROSOLS. Raabe, Otto George. Rochester, N. Y., Univ. of Rochester, 1967. 186p.

Thesis.

The adsorption of Rn daughters onto uncharged polystyrene aerosols in the diameter range from 0.04 to 0.5 μ was studied under carefully controlled and measured laboratory conditions. Electron microscope samples collected with a point-to-plane electrostatic precipitator were used to characterize the aerosols. Two procedures for handling particle size data are discussed. A method for analyzing the deposit of aerosols collected with the Goetz Aerosol Spectrometer is described, and this method was used to study the distribution of Rn daughters, which were attached to test aerosols after Rn gas in concentrations of about 2×10^{-8} Ci/l was allowed to interact with aerosols in concentrations of the order of 10^4 particles/cc for various periods of the order of 20 min. A new method of analyzing Rn daughter samples from gross α particle counting is described. The Rn daughter distribution was proportional to the surface area distribution of the aerosol particles to which the Rn daughters were attached. It is suggested that this effect is caused because the Brownian motion of the aerosol particles cannot be ignored even though the diffusion coefficients are relatively small. When the interaction rate of a highly diffusible material is small, as is normally the case with Rn daughters interacting with aerosol particles, the Brownian motion of the aerosol particles prevents the establishment of a diffusion steady state, and the particles are always in a uniform concentration environment. The resulting interaction rate is proportional to the surface area of the particles as predicted from kinetic theory. This principle was used to calculate the size distribution of some natural aerosols with which similar levels of Rn gas were mixed. The result was in excellent agreement with the model of the size distribution of natural aerosols that has been suggested by Junge over the size range from 0.03 to 0.5 μ in diameter. (Disser. Abstr.)

37766 SELENIUM DIOXIDE OXIDATIONS. III. THE OXIDATION OF OLEFINS. Schaeffer, John P.; Horvath, Bert; Klein, Howard P. (Univ. of Arizona, Tucson). J. Org. Chem., 33: 2647-55(July 1968).

Details of the oxidation of deuterium-labeled 1,3-diphenylpropene with selenium dioxide were studied. In acetic acid at 115° an isotope effect (k_H/k_D) of 3.2 was observed for oxidation at the benzylic position; this indicated that an allylic carbon–hydrogen bond was being broken in the rate-determining step. Oxidation was most rapid for electron-rich olefins and was hindered if the double bond was shielded. A mechanism is proposed that involves the formation of an allylic selenium(II) ester (RCH = CHCHROSeOH) that decomposed to products through a solvolysis reaction. Evidence for a second pathway for oxidation is presented. This proceeded through the addition of selenium dioxide and acetic acid to the double bond, followed by pyrolysis of the selenoxide that was produced to the allylic acetate. The intermediate in this reaction was isolated and characterized. Oxidation of the optically active 3- and 4-methylcyclohexenes in acetic acid in n-butanol was investigated, and products that arose from the introduction of oxygen into the 2, 3, and 4 positions were isolated. For the oxidation of the olefins in n-butanol, it was found that the product that was formed was in each case the thermodynamically unstable ether. An analysis of the data suggests that oxidation occurs through addition of selenium dioxide and solvent to the double bond, followed by pyrolytic elimination of selenium in a lower oxidation state to produce allylically oxidized product. (auth)

37767 RATE STUDIES AND THEIR MECHANISTIC IMPLICATIONS FOR THE REACTION OF 2-METHYLQUINOLINE 1-OXIDE AND ACETIC ANHYDRIDE. Muth, Chester W.; Darlak, Robert S.; DeMatte, Michael L.; Chovanec, Gerald F. (West Virginia Univ., Morgantown). J. Org. Chem., 33: 2762-7(July 1968).

The rate of reaction of 2-methylquinoline 1-oxide (1) with acetic anhydride has been measured by three methods which gave similar results. The rate constants are believed to be a product of the equilibrium constant for reaction of 1 with acetic anhydride to form 1-acetoxy-2-methylquinolinium acetate (2) and of a rate constant for the latter to yield 2-quinolylmethyl acetate (4). α,α,α-Trideuterio-2-methylquinoline 1-oxide was found to react one-half as rapidly as the undeuterated derivative. This, plus the fact the product (4) formed at about the same rate as the equilibrium mixture of 1 and 2 disappeared, indicates that removal of a methyl hydrogen is the rate-determining step. Also it can be seen that any intermediate between 2 and 4 must have a very fleeting existence. (auth)

37768 FLUORESCENCE OF URANIUM-ACTIVATED COMPOUNDS WITH ROCKSALT LATTICE. Blasse, G. (Philips Research Labs., Eindhoven, Netherlands). J. Electrochem. Soc., 115: 738-42(July 1968).

The green fluorescence of the following phosphors is reported: Li_3NbO_4-U, Li_3SbO_4-U, Li_2SnO_3-U, $LiScO_2$-U, and MgO-U. Their crystal structures are based on the rocksalt lattice. It is found that for increasing lithium content of the host lattice the position of the maximum of the emission band shifts to shorter wavelengths and the quantum efficiency increases. This relation is discussed. Concentration quenching occurs at low activator con-

centration. Y_6WO_{12}-U with regular UO_6 octahedra emits also in the green. For some other compounds red emission was found. Green uranium emission is assigned to UO_6 groups and uranyl (UO_2) groups, red emission to UO_4 groups. It is shown that this assignment is consistent with the structural data for a large number of uranium-activated oxides. Energy transfer was observed between the uranium center and Eu^{3+}. Addition of Cr^{3+} or Rh^{3+} quenches the uranium fluorescence drastically. (auth)

37769 ELECTRON-COLLISION INDUCED FRAGMENTATION OF ACETYLENE COMPOUNDS. II. Bohlmann, Ferdinand; Zdero, Christa; Bethke, Hartmut; Schumann, Dieter (Technische Univ., Berlin). Chem. Ber., 101: 1553-70(1968). (In German).

The highly resolved mass spectra of numerous deuterated acetylene compounds gave a very clear mechanism for their fragmentation induced by electron collision. (tr-auth)

37770 VIBRATIONAL SPECTRA AND NORMAL VIBRATIONS OF ACETANILIDE AND N-DEUTERATED ACETANILIDE. Venkata Chalapathi, V.; Venkata Ramiah, K. (Osmania Univ., Hyderabad, India). Proc. Indian Acad. Sci., Sect. A, 67: 184-98(Apr. 1968).

The Raman and infrared spectra of acetanilide and N-methylacetamide and of their N-deuterated compounds were recorded. The vibrational frequencies of acetanilide were assigned and the nature of the amide I, II, and III bands in acetanilide and N-methylacetamide were investigated by the study of the changes in the frequencies of these bands in the spectra of their deuterated compounds. Acetanilide and deuterated acetanilide molecules were subjected to normal co-ordinate treatment and the mixing up of the skeletal frequencies arising out of the in-plane vibrations were determined. These results indicate that as in secondary amides, the amide II and amide III bands in acetanilide are due to the combined contribution of δ(NH) and ν(C—N) vibrations, but the contribution of ν(C—N) to the amide II band is less in acetanilide and deuterated acetanilide than in cases of N-methylacetamide and deuterated N-methylacetamide. (auth)

37771 ACETOACETANILIDE AND ACETOACET-O-CHLOROANILIDE COMPLEXES OF URANYL. Sen, D. N.; Thankarajan, N. National Chemical Lab., Poona). Indian J. Chem., 6: 278-9 (1968).

Uranyl complexes of acetoacetanilide and acetoacet-o-chloroanilide (indexed as 2-chloroacetoacetanilide) were prepared and characterized. Whereas the usual β-dicarbonyl chelates of uranyl conform to the UO_2A_2 type, the compounds reported herein were found to be of the $UO_2A_2.HA$ type. Thermogravimetric analysis revealed that the third molecule of the ligand is held less firmly than the other two. Infrared spectral evidence led to a coordination number seven for uranium in these compounds. (auth)

37772 METHOD OF PREPARATION OF POLLUCITE AND ITS APPLICATION TO THE PRODUCTION OF RADIOACTIVE SOURCES. Olombel, Andre; Perebaskine, Cecile; d'Albian, Le Val; Raggenbass, Andre (to Commissariat a l'Energie Atomique). British Patent 1,119,768. July 10, 1968. Priority date June 23, 1965, France.

Pollucite suitable for the preparation of radioactive sources was prepared by mixing a colloidal aqueous solution of silica with aqueous solutions of nitrates of Cs and Al in stoichiometric quantities, evaporating the mixture to dryness with stirring, heating the dry mixture to a temperature below 1000°C, compacting, and sintering at 1600°C. Cesium-137 is used to prepare the radioactive source. (B.L.M.)

37773 STUDIES OF THE PHASE DIAGRAM OF ^{3}He–^{4}He LIQUID MIXTURES BELOW 1°K. Graf, Erlend Haakon. Ithaca, N. Y., Cornell Univ., 1968. 104p.

Thesis.

The phase diagram of ^{3}He–^{4}He liquid mixtures was investigated in the region near the limit of ^{3}He solubility and near the consolute point. Data on the phase separation curve for low ^{3}He concentrations (6.6 to 8.5 mole %) were obtained by a nuclear resonance technique in which formation of the ^{3}He-rich phase is detected by a small (1% of the sample volume) coil located in the top of the chamber. The results indicate the limit of ^{3}He solubility at absolute zero to be below 6.6 mole %. The phase separation curve near the consolute point was determined by a dielectric constant measurement. Two small capacitors, each comprising about 1.5% of the sample volume are used to monitor the dielectric constants of each of the liquid phases, from which the density and ^{3}He concentration can be deduced. The high and low concentration branches of the phase separation curve approach each other linearly and appear to intersect at an angle, forming a sharp peak. Determination of the λ line in this region by thermal response time measurements indicate that it intersects the phase separation curve at the peak. The peak is located at 872 ± 3 mdeg K and 66.9 ± 0.5 mole % ^{3}He on a temperature versus concentration plot under conditions of saturated vapor pressure. (Disser. Abstr.)

37774 MICROCALORIMETRIC, E.M.F., AND SOLUBILITY STUDIES OF NEPTUNIUM COMPOUNDS. Brand, John Robert. Lafayette, Ind., Purdue Univ., 1967. 114p.

Thesis.

The solubility and heat of solution of $NpO_2(NO_3)_2 \cdot 6H_2O$ were measured, giving values of 2.95 ± 0.26 molal and 5.060 ± 0.090 kcal/mole, respectively. The heat of the reaction of $NpO_{2(aq)}^{2+}$ with $H_2O_{2(aq)}$ was experimentally fixed at 10.310 ± 0.290 kcal/mole, which in turn, when combined with auxiliary data for $H_2O_{2(aq)}$, yielded ΔH^0 = 28.00 ± 0.14 kcal/mole for the Np(V)/Np(VI) half reaction. The emf measurements for the Np(V)/Np(VI) electrode placed the E^0 value for this couple at −1.130 ± 0.010 abs V. These values combined with a reasonable estimate (−123.4 ± 1.1 eu) of the entropy of $NpO_2(NO_3)_2 \cdot 6H_2O$ gave entropies of −11 ± 2 eu and −20 ± 2 eu for $NpO_{2(aq)}^{2+}$ and $NpO_{2(aq)}^{+}$, respectively. Estimates are given for individual ionic entropies of other actinide MO_2^+ and MO_2^{2+} ions as well as ΔS^0 and ΔH^0 values for their half reactions. (Disser. Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstracts 37678, 37707, 37709, and 37869.

37775 (BNL–50082, pp 40–78) RADIATION DIVISION. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.).

Developments are reported for studies on: solid state reactions; radiolysis of aromatic compounds; vinyl polymerization mechanisms; radiolysis in the adsorbed state; polymerization of composite materials; heterogeneous radiation chemistry; radiation effects on electrode reactions; radiation treatment of acid mine drainage; survey experiments; chemonuclear program; economics and evaluation of chemonuclear and nuclear complex systems; radiation engineering in the high intensity radiation development laboratory; radiation sources; radiation chemical reactors; closed-cycle nonequilibrium nuclear magnetohydrodynamics; and atmospheric sulfur pollutants. (P.C.H.)

37776 (BNL–50082, pp 79–92) HOT LABORATORY DIVISION. Stang, L. G. Jr. (Brookhaven National Lab., Upton, N. Y.).

Developments are reported for studies on: chemical effects of Te isomer decay; Szilard–Chalmers reactions in metallophthalocyanines and zirconocene and hafnocene dichlorides; excitation functions for alpha particles on ^{27}Al; synthesis of transplutonic nuclides by epithermal neutrons; isotope applications development for ^{125m}Te and ^{99m}Tc; nickel(II) halide complexes in acetonitrile; platinum(IV) halides; mixed β-diketone complexes of Cu(II) and In(III); and radioisotope production and shipment. (P.C.H.)

37777 (CEA-R–3379) RECHERCHES SUR LA SYNTHESE DE L'HYDRAZINE ANHYDRE. (Research on Anhydrous Hydrazine Synthesis). Gaussens, Gilbert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 106p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The radiolysis of pure liquid ammonia was investigated and the fundamental importance of the dose rate and of the dose on the yield of radiolytic products was demonstrated. By using a capture solute at concentrations of between 10^{-3} and 1.2 moles/l, it was possible to determine the yields of radicals and of molecules in the irradiated pure ammonia. By systematically varying the physicochemical parameters, the most favorable conditions for carrying out the radiosynthesis were determined. The maximum radiochemical yield of the hydrazine obtained had a value G (N_2H_4) = 2.2/100 eV. An analysis of the molecular yields in the presence of deuterated solutes makes it possible to explain partially the role of the capture species. An installation for the continuous production of hydrazine is described, and an economic study of the process given. Results show that the yields of hydrazine obtained justify an industrial application, especially if strong radiation sources are available, for example nuclear reactors. (auth)

37778 (CEA-R–3384) UNE METHODE DE PRODUCTION D'EUROPIUM 155 SANS ENTRAINEUR AU NIVEAU DU CURIE. (Method of Production of Carrier-Free ^{155}Eu at the Curie Level). Falconi, Nicole; Radicella, Renato (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 17p. (In French). Dep.

High-activity "point" sources of ^{155}Eu are used for medical and industrial applications. A method for obtaining curie amounts of carrier-free ^{155}Eu, with a solid residue smaller than 5 mg per Ci, was studied. In order to separate the Eu from several grams of a ^{154}Sm-enriched target a procedure is proposed that is based on the work of Bouissières and David, Onstott, and Takekoshi et al. The separation is carried out by electrolysis on a mercury cathode followed by purification on ion exchange resin. The yields

of the europium separation and target recovery are 80 and 90%, respectively. The time required for the procedure is 3 days. (auth)

37779 (ORNL-tr-1969) FREE RADICALS FORMED BY THE IRRADIATION OF HIGH POLYMERS AND THEIR TRANSFORMATIONS. Ueda, Hisashi; Shida, Shoji; Kuri, Zenichiro. Translated for Oak Ridge National Lab., Tenn., from Shinku Kagaku, 15: No. 1, 3-4(1967). 5p. Dep. CFSTI.

Transformations of free radicals in high polymers were observed through their reactions with various gases. The behavior of these free radicals was interpreted by the physical and chemical properties of individual high polymers. High polymers were classified into 5 groups according to the transformation processes of the free radicals formed in them. (auth)

37780 (RRL-2310-242) [RADIATION RESEARCH]. Quarterly Report, April 1, 1968-June 30, 1968. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). July 8, 1968. Contract AT(30-1)-2310. 16p. Dep. CFSTI.

Research progress is reported on: repetitive flash photolysis, near infrared detection system, ESR detection of transient species, produced by a Van De Graaff accelerator, computer analysis of 35 GHz single crystal spectra, photosensitized photolysis of cyclopropane, ion and hydrogen atom scattering in cyclohexane, electron scavenging by CH_3Br in liquid hydrocarbons, electron scavenging by propyl bromides, hydrogen abstraction by CF_3, and intermediates in nucleophilic aromatic substitutions. (M.C.G.)

37781 (UCRL-17989) NUCLEAR CHEMISTRY DIVISION ANNUAL REPORT, 1967. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 334p. Dep. CFSTI.

Research in nuclear chemistry is reported under the following headings: nuclear spectroscopy, nuclear reactions and scattering, nuclear structure theory, fission, hyperfine interactions, chemistry, mass spectroscopy, chemical engineering, and instrumentation. Separate abstracts were prepared for each of the nine sections. (M.C.G.)

For abstracts of individual sections see: 37717, 37718, 37931, 37998, 38150, 39638-39640, and 39695.

37782 FREE RADICAL CHEMISTRY OF WHITE PHOSPHORUS: γ-IRRADIATION OF P_4 IN BROMOFORM. Airey, P.; Drawe, H.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 23b: 916-21(July 1968).

$CHBr_2PBr_2$ and $(CHBr_2)_2PBr$ are formed in high yields and in preparatively useful amounts when solutions of white phosphorus in bromoform are exposed to γ-radiation. In the first stages of irradiation, a red phosphorus containing many groups from the solvent is the only reaction product. About 1000 molecules of P_4 are consumed per 100 eV of energy absorbed. In the later stages of irradiation, free radicals from the solvent attack this red phosphorus and lead to the formation of bromophosphines in high yield. Chain reactions are formulated for the formation of both the red phosphorus and the bromophosphines. (auth)

37783 RADIATION CROSSLINKING OF HYDROGENATED POLYETHYLENE. Salovey, R.; Hellman, M. Y. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Polym. Sci., Part B, 6: 527-9(July 1968).

Studies were made to determine whether variations in radio-induced crosslinking efficiency, associated with the packing of lamellar crystals of linear polyethylene, are also suppressed in the absence of vinyl end groups. Accordingly, films (2.5 and 40 mil thick) of hydrogenated polyethylene were prepared and exposed to electrons from a Van de Graaff generator. The results showed that differences in crosslinking efficiency did not involve vinyl end group reactions. (P.C.H.)

37784 THE REACTION OF WHITE PHOSPHORUS WITH DIMETHYL SULFIDE UNDER γ-IRRADIATION. Scheffler, M.; Drawe, H.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 23b: 911-15(July 1968). (In German).

Trimethylthiophosphite and red phosphorus are formed when solutions of white phosphorus in dimethyldisulfide are exposed to γ-radiation. The red phosphorus has a high content of CH_3S groups. It is very reactive and can be converted into trimethylthiophosphite upon further irradiation in dimethyldisulfide suspension. Both the formation of red phosphorus from white phosphorus and the formation of trimethylthiophosphite from red phosphorus are chain processes. The radiation chemical yields are of the order of several 100 molecules/100 eV at room temperature. (auth)

37785 REACTIONS OF ENERGETIC CHLORINE ATOMS WITH METHYL CHLORIDE IN THE GAS PHASE. Wai, Chien M.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Amer. Chem. Soc., 90: 3638-46(July 3, 1968).

The reactions of energetic chlorine atoms with methyl chloride in gas phase were studied in detail, using the technique of nuclear recoil. Both substitution products, Cl for Cl and Cl for H, were observed in yields of 3.1 and 0.7%, respectively, for well-scavenged gaseous samples. The substitution reactions were confirmed as hot, and not thermal, processes by diminishing their yield with helium and neon as inert moderators. Quantitative evaluation of the kinetic theory parameters shows that the α values (moderator efficiencies) of CH_3Cl/Ne/He are in the ratio 3.0/1.0/0.41. The high value for CH_3Cl indicates substantial energy loss in highly inelastic collisions; the "billiard-ball" ratio for Ne/He would be 1.0/0.26. The chemical reactions were studied using both $^{37}Cl(n,\gamma)^{38}Cl$ and $^{40}Ar(\gamma,p)^{39}Cl$ as the nuclear reaction source, with results in excellent agreement with each other. The absolute yields of the $^{37}Cl(n,\gamma)^{38}Cl$ reaction were internally monitored with the $^{40}Ar(n,\gamma)^{41}Ar$ reaction. All of the observed reactions can be consistently interpreted as chemical reactions of neutral ground-state chlorine atoms with excess kinetic energy. (auth)

37786 SYNTHETIC SAPPHIRE REACTION VESSEL FOR RADIATION CHEMISTRY. Campanile, V. A. (Shell Development Co., Emeryville, Calif.). Int. J. Appl. Radiat. Isotop., 19: 540 (June 1968).

In the course of some radiation chemistry studies, including compounds of fluorine at cryogenic temperatures, the need arose for non-reactive reaction vessels that would remain transparent on exposure to high energy radiation, and in this connection the utility of designated uv grade synthetic sapphire vessels is described. This material remained clear and colorless after exposure to 10^8 rad/hr for 60 min and upwards at -195°C, and proved generally very satisfactory. The material displayed no ESR signal after irradiation at 77°K, although strong luminescence was observed on heating rapidly to room temperature, indicating trapping of some kind of excited species. (UK)

37787 DISULFIDE IONS PRODUCED IN γ-IRRADIATED ORGANIC GLASSES AT -196°. A PHOTOCHROMISM OF THE ANION. Shida, Tadamasa (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Chem., 72: 2597-2601(July 1968).

Molecular positive and negative ions of alkyl and aromatic disulfides were produced in rigid matrices γ irradiated at -196°C. Disulfide anions absorb strongly at about 420 mμ, while the corresponding cations exhibit a weak absorption at 600 to 900 mμ. A photochromism was found for alkyl disulfide anions in nonprotic matrices, which were ascribed to a rotational isomerization of the anion. In protic matrices the rotation is hindered by the hydrogen bridge. In contrast with the alkyl disulfide anions, photoexcitation of dibenzyl and dibenzhydryl disulfide anions results in the splitting of benzyl and benzhydryl radicals, respectively. (auth)

37788 EVIDENCE FOR ELECTRON MIGRATION DURING γ-IRRADIATION OF SILICA GEL: REACTIONS OF ADSORBED ELECTRON SCAVENGERS. Wong, P. K.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 72: 2623-7(July 1968). (COO-1715-143).

To study whether long-range electron migration may occur in silica gel during γ irradiation, the yields of products of electron attachment to adsorbed alkyl halides, galvinoxyl, naphthalene, and biphenyl were investigated as a function of concentration of these electron scavengers. The ESR and optical spectra of the sorbed radical and anion products are directly identifiable with the spectra produced by γ irradiation or chemical reduction of the sorbate species in organic solution, except for the case of naphthalene. G values, calculated on the basis of total energy absorbed in the SiO_2, are all greater than unity and are nearly independent of concentration of the sorbate to concentrations at least as low (in the case of galvinoxyl) as 5×10^{-6} mol fraction. This is consistent with the conclusion that electrons ejected by the ionizing radiation migrate very extensively through the SiO_2 matrix. No radicals were generated when alkyl halides were added to silica gel following irradiation of the gel. (auth)

37789 REACTION OF RECOIL TRITIUM WITH METHYLSILANES. Witkin, Judith; Wolfgang, Richard (Yale Univ., New Haven). J. Phys. Chem., 72: 2631-4(July 1968).

The reactions of hot hydrogen atoms, in the form of tritium recoiling from nuclear reactions, with methylsilanes were studied. Reaction types found are similar to those with homologous hydrocarbons and are in accord with the previously postulated reaction models. A greater reactivity of silanes, especially for abstraction processes, appears related to the weakness of the Si-H bond. Yield patterns of reactions involving rupture of C-Si bonds correlate with known properties of silicon bonds and inertial restrictions on relaxation motions. (auth)

37790 THE MECHANISM OF HYDROGEN FORMATION IN THE γ RADIOLYSIS OF 1,4-DIOXANE AND ITS MIXTURES WITH WATER. Hentz, Robert R.; Sherman, Warren V. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 72: 2635-41(July 1968). (COO-38-589).

In the γ irradiation of pure liquid, 1,4-dioxane, $G(H_2) = 1.31$ was obtained. The hydrogen yield is suppressed to a limit of $G(H_2) \approx 1.0$ by the H atom scavenger 1-hexene and by the electron scavengers N_2O and c-C_4F_8. Consequently, $G(H_2) \approx 1.0$ is attributed to molecular elimination from directly excited dioxane molecules. The yield of scavengeable electrons, as determined with N_2O and 0.1 N H_2SO_4, corresponds to G = 3.1 to 3.4. Thus $G(H_2) \approx 0.3$ results from H atoms produced with ~10% efficiency in the neutralization of dioxane cations by electrons. An enhancement of $G(H_2)$ by NH_3 is observed that indicates proton transfer from a dioxane cation to give NH_4^+, which on neutralization by an electron presumably yields H with unit efficiency. Water is considerably less effective than NH_3 in the enhancement of $G(H_2)$; the results suggest that the specific rate of proton transfer to H_2O is less than that to NH_3 in liquid dioxane. As the water–dioxane composition is varied over the whole range, $G(H_2)$ passes through a maximum. Such behavior is related to a change in the yield of free solvated electrons with change in the dielectric constant of the medium. The presence of dioxane in cyclohexane causes a suppression of $G(H_2)$, which is restored by the addition of methanol or NH_3. The results indicate that positive charge is transferred from cyclohexane cations to dioxane and that the added base scavenges cations of both cyclohexane and dioxane with about equal efficiency. (auth)

37791 KINETICS OF THE REACTION OF TRAPPED HYDROGEN ATOMS IN SULFURIC ACID GLASSES. Vacek, K.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). J. Phys. Chem., 72: 2686-8(July 1968).

The kinetics of the disappearance of trapped H atoms, produced by γ-irradiation, in a glassy matrix of 6 M H_2SO_4 in the absence and presence of 2-propanol was investigated. The G(H) values were 2.3 and 0.9 in the absence and presence of 0.35 mol of 2-propanol, respectively. In the absence of 2-propanol, the H atoms disappeared completely at 90°K while only 15% of the central part of the ESR spectra (attributed to $HSO_4\cdot$ or $SO_4^-\cdot$) diminished. Because of time-dependent rate constant it was assumed there was a random distribution of trapped H atoms. It was concluded that the occurrence of a rapid initial period and deviations from simple kinetics for bimolecular reactions in the condensed phase are not sufficient to postulate a nonrandom distribution of the reaction particles. (D.H.M.)

37792 RADIOLYSIS OF AQUEOUS CHROMIUM AND VANADIUM IN THEIR +2 AND +3 OXIDATION STATES. Lykourezos, P. A. P.; Kanellopoulos, A.; Katakis, D. (Democritos Nuclear Research Center, Athens). J. Phys. Chem., 72: 2330-5(July 1968).

In the radiolysis of aqueous Cr^{II}, the product Cr^{III} appears in the form of various complexes, depending on the oxidizing agent. In perchloric acid solutions, monomeric and dimeric Cr^{III} are the sole products, their yields increasing with increasing $HClO_4$ concentration. In H_2SO_4 the products are the Cr^{III} monomer and the sulfate complex. The chloro complex in the acid region studied is formed only if Cl^- is added to the initial Cr_{aq}^{2+} solution, the yield depending on the $(Cl^-):(Cr^{2+})$ ratio, the total $G(Cr^{III})$ remaining constant for a given $HClO_4$ concentration; all evidence points to the conclusion that this complex is formed only by paths catalyzed by chloride. The hydrolysis of the Cr^{III} dimer and the chloro complex is accelerated by radiation, but it does not compete with Cr^{2+} oxidation. In the radiolysis of V^{2+}, deaerated V^{3+} and air-saturated V^{3+} solutions, the G values are 8.2, 0.9, and 15.5, respectively. The results with the $Cr^{II}-Cr^{III}$ system are discussed with a bias toward its characteristics that seem useful in studying unknown intermediates. (auth)

37793 STUDIES IN THE AQUEOUS RADIATION CHEMISTRY OF CYSTEINE. I. DEAERATED ACIDIC SOLUTIONS. Al-Thannon, Adnan; Peterson, Richard M.; Trumbore, Conrad N. (Univ. of Delaware, Newark). J. Phys. Chem., 72: 2395-2400 (July 1968). (NYO-3383-9).

Results of studies on the ^{60}Co γ-radiolysis of acidic cysteine (RSH) solutions, pH 1.0 and 0.5, are reported. Irradiation products that were identified are H_2, H_2S, RSH, and H_2O_2 with radiation yields at 10^{-3} M cysteine of 3.2, 0.95, 3.0, and 0.68 molecules/100 eV absorbed. Alanine was also observed qualitatively as a radiation product. Yields for the disappearance of the thiol group were measured polarographically during the irradiation and G(–RSH) was found to be 7.0 at 10^{-3} M cysteine. A mechanism is postulated for strongly acid cysteine solutions on the basis of competition kinetics, material balances, and comparison with theoretical yields. Analysis of results of competition studies provides evidence for a rate constant of approximately 3×10^{10} l. mol^{-1} sec^{-1} for the reaction of the hydrated electron with the protonated-amine form of cysteine. Results of scavenger studies at concentrations higher than 10^{-2} M cysteine require that additional processes be postulated in order to account for high H_2S yields. (auth)

37794 RECOIL THERMAL ANNEALING IN BROMATES. I. THE ROLE OF INHERENT CRYSTAL DEFECTS. Campbell, I. G. (Univ. of Manchester, Eng.); Jones, C. H. W. Radiochim. Acta. 9: No. 1, 7-12(May 1968).

The thermal annealing of (n,γ) activated ^{80m}Br recoils in crystalline sodium bromate was investigated. Different crystalline samples yielded different results for isochronal thermal annealing experiments, indicating a varying sensitivity of the samples to recoil annealing. Heating the crystals before the neutron irradiation increased the initial retention for subsequent (n,γ) activation, while decreasing the sensitivity of the lattice to post-neutron recoil annealing. The results were interpreted in terms of the role played by inherent crystal defects in recoil thermal annealing processes. (auth)

37795 ION–MOLECULE REACTIONS IN GASEOUS BENZENE AND TOLUENE. Wexler, S.; Clow, R. P. (Argonne National Lab., Ill.). J. Amer. Chem. Soc., 90: 3940-5(July 17, 1968).

The ion-molecule reactions of positively charged species in pure benzene and toluene were studied mass spectrometrically in the range of source pressures from 0.005 to 0.32 torr. Although more than 200 ionic species were observed for each gas, most were of low relative abundance, and the mass spectra consisted of only a few important species. By far the most prominent reactions in benzene were the condensation of $C_6H_7^+$ with a benzene molecule to form $C_{12}H_{12}^+$ and the formation of $C_6H_6^+$ by charge transfer from fragment ions. In gaseous toluene the dominant product ions were the $C_{14}H_{15}^+$ and $C_{14}H_{16}^+$ dimers formed by condensation of $C_7H_7^+$ and $C_7H_8^+$ with a toluene molecule, respectively. Again, charge exchange from fragment ions to give $C_7H_8^+$ was an important reaction. The dimeric species appeared to be unreactive or only slightly reactive with the respective gas. Correlations with observations on the radiolysis of these compounds are drawn, and ionic mechanisms for the formation of polymeric species by radiation are proposed. (auth)

37796 KINETICS OF REACTIONS OF ELECTRONS DURING RADIOLYSIS OF LIQUID METHANOL AND REACTION OF ELECTRONS WITH LIQUID ALCOHOLS AND WITH WATER. Jha, K. N.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 5480-90(June 15, 1968).

The γ-radiolysis of liquid methanol was studied over the temperature range from its melting point (–98°C) to its critical temperature (240°C). The value of $G(H_2)$ varies from 4.9_5 at –98°C to 5.4_3 at 25°C and 8.0 at 240°C. Sulfuric acid and nitrous oxide were added as electron scavengers at –97, 25, and 150°C. The nitrogen and hydrogen yields were calculated as functions of the nitrous oxide concentration at each of the three temperatures. The calculations were based on a proposed mechanism. Homogeneous kinetics were used for the reactions of the free ions and non-homogeneous kinetics were used for the reactions in spurs. At –97°C, G(total ionization) = 4.6 and the value is assumed to be independent of temperature. The yield of free ions is $G(e^-_{solv})_{fi} = 2.0 \pm 0.2$, independent of temperature from –97 to 150°C. The reaction $e^-_{solv} \rightarrow CH_3O^-_{solv} + H$) has a rate constant of 4.6×10^5 sec^{-1} at 25° and an activation energy equal to that of dielectric relaxation (3.7 kcal/mole); the entropy of activation of the reaction is –21 cal/deg·mole. In each of the liquids methanol, ethanol, isopropanol, and probably also water, the reaction $e^-_{solv} \rightarrow RO^-_{solv} + H$ has an activation energy approximately equal to that of dielectric relaxation and has a large negative entropy of activation. The large negative entropy of activation indicates that the transition state has a relatively specific structure. It is suggested that solvated electrons are liquid-structure breakers in water and relatively weak structure formers in the alcohols. (auth)

37797 VINYL CELLULOSE COPOLYMERS. PART I. EFFECT OF METHOD OF PREPARATION ON THE PROPERTIES OF POLYACRYLONITRILE-COTTON COPOLYMERS. Blouin, Florine A.; Morris, Nelle J.; Arthur, Jett C, Jr. (Southern Regional Research Lab., New Orleans). Text. Res. J., 38: 710-16(July 1968).

Polyacrylonitrile–cotton copolymers were prepared by post-irradiation, simultaneous-irradiation, ceric ion, and ferrous ion/hydrogen peroxide-initiated graft copolymerization reactions. Molecular weights of the grafted polyacrylonitrile ranged from 33,000, when the simultaneous-irradiation method and dimethylformamide solvent were used, to 1,200,000 when the post-irradiation method and 75% aqueous zinc chloride solvent were used. The location of the grafted polyacrylonitrile ranged from principally

the outer layers of the fibrous structure to uniform distribution within the structure. All of the textile properties of cotton yarns and fabrics, which had been graft-copolymerized with acrylonitrile, were apparently not wholly dependent on the molecular weight of the grafted polyacrylonitrile, the fraction of the cellulose molecules containing grafted polyacrylonitrile, or the distribution of the polymer within the fibrous structure. Of the properties evaluated, only the flat abrasion resistances of cotton fabrics, copolymerized with acrylonitrile using radiation methods and aqueous zinc chloride solvent, were significantly greater than those of copolymers prepared by other methods. The wrinkle recoveries of fabrics, containing the polyacrylonitrile which had the lowest molecular weight, were greater than those for fabrics grafted with polyacrylonitrile which had higher molecular weight. The relationships between the site of the cellulose molecule of the graft copolymerization reaction to the method of initiation and the properties of the cotton copolymers were considered. (auth)

37798 MEASUREMENT OF THE RELATIVE ABUNDANCES AND RECOIL ENERGY SPECTRA OF FRAGMENT IONS PRODUCED AS THE INITIAL CONSEQUENCES OF X-RAY INTERACTION WITH C_2H_5I, CH_3CD_2I, AND $Pb(CH_3)_4$. Carlson, Thomas A.; White, R. Milford (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 5191-4(June 1, 1968). (ORNL-P-3666).

The fragment ions produced as the initial consequence of x irradiation of C_2H_5I, CH_3CD_2I, and $Pb(CH_3)_4$ were measured with a specially designed mass spectrometer for their relative abundances and kinetic-energy spectra. In the case of iodine-containing molecules x irradiation was expected to cause photoionization primarily in the L shell, and in the case of lead, the M or L shells. The molecules decomposed nearly completely into their constituent elements as the result of the high degree of ionization resulting from the reorganization of the heavy atoms to an inner-shell vacancy by means of Auger processes. Calculations based on the Coulombic repulsion of point charges were compared with the experimentally determined recoil energies. Agreement was reasonable, although the experimental values were generally lower than the calculated ones. The relative recoil energies of H^+ and D^+ from the study on deuterated ethyl iodide suggest that the β carbon on the average loses as many electrons as the carbon next to the iodine; while the low recoil energy of Pb suggests that the decomposition of highly charged tetramethyl lead is essentially symmetrical. (auth)

37799 EPR STUDIES OF LOW-TEMPERATURE RADIOLYSIS OF THIOLS. Barsegov, R. G.; Bichiashvili, A. D.; Panchvidze, M. V.; Nanobashvili, E. M. (Inst of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 49: 91-6(Jan. 1968). (In Russian).

EPR studies of low-temperature (77°K) γ-radiolysis of ethane-, butane-, pentane-, hexane-, dodecane-, and octadecane thiols and benzyl mercaptans revealed that ions, radicals, and captured electrons are the primary products of radiolysis. The portion of alkyl radicals increased with increased energy absorption and length of hydrocarbon chain. It is also shown that following uv illumination of γ-irradiated thiols the ion radicals converted into sulfur radicals RS. Heating of γ-irradiated specimens produced identical results. A scheme of low-temperature radiolysis of thiols is included. (R.V.J.)

37800 SOLUBILITY OF GRAFT-COPOLYMERS OF PERVINYLCHLORIDE WITH POLYSTYRENE OBTAINED BY RADIATION. Tashmukhamedov, S. A.; Usmanov, Kh. U.; Tillaev, R. S. Vysokomol. Soedin., Ser. A, 10: 1303-7(June 1968). (In Russian).

The solubility of graft-copolymers of pervinylchloride with polystyrene as a function of the conditions of synthesis has been studied. Dependences of integral heats of swelling, specific weights, and intrinsic viscosities on dose and dose rates were also determined. (auth)

37801 RADIATION INDUCED INCREASE OF STABILITY OF POLYMERIZING EMULSION SYSTEMS. Lukhovitskii, V. I.; Polikarpov, V. V.; Lebedeva, A. M.; Lagucheva, R. M.; Karpov, V. L. Vysokomol. Soedin., Ser. A, 10: 1297-1302(June 1968). (In Russian).

Kinetics of the radioinduced polymerization and post-polymerization of styrene in emulsion have been studied in comparison with chemically initiated polymerization. The rate of radiation polymerization was many times higher than when initiated with substantial initiators. γ-Irradiation increased stability of emulsion systems containing anionic emulsifiers. The rate dependence of post-polymerization on emulsifier concentration has been determined. (auth)

37802 SELF-RADIOLYSIS OF TRITIATED COMPOUNDS. Guarino, A.; Pizzella, R.; Possagno, E. (Univ., Rome). J. Label. Compounds, 4: 147-58(Apr.-June 1968).

The self-radiolysis of methyl stearate-9,10-^{3}H has been studied with particular attention to the determination of its percent decomposition, its G(-M) value, as well as yields of the radiolysis products. Reliable figures have been obtained with the use of accurate experimental techniques, in particular the reverse isotopic dilution method coupled to preparative gas chromatography. (auth)

37803 COMPARISON OF THE YIELDS OF PARAMAGNETIC SPECIES IN RADIOLYSIS OF GLASSY METHANOL BY β AND γ RADIATION. Habersbergerova, A. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 33: 1925-9(June 1968).

Comparisons were made under identical conditions, by means of ESR, of the yields of trapped electrons and of CH_3OH radicals after optical bleaching in glassy methanol irradiated with ^{60}Co gamma rays and T beta particles. The concentration of paramagnetic species was not affected by optical bleaching. The yield of trapped electrons in radiolysis by beta particles was ~15% lower than that in gamma radiolysis. (M.C.G.)

37804 RADIATION EFFECTS ON FORMATION OF THIOCYANIC ACID ESTERS. Chirakadze, G. G.; Nanobashvili, E. M.; Mosashvili, G. A. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 50: 361-6(May 1968). (In Russian).

Optimum conditions for radioinduced production of thiocyanic acid esters were studied using 1-hexene, 1-heptene, 3-heptene, and potassium and ammonium thiocyanates irradiated with 1.7×10^{16} eV/ml · sec γ radiation and 0.9 to 1.5×10^{15} eV/ml · sec x radiation and using ethyl alcohol and acetone as solvents. Formation of thiocyanic acid esters with high radiochemical yield was observed in inert gas media. (R.V.J.)

37805 RADIOLYSIS OF POTASSIUM AND AMMONIUM THIOCYANATES IN ETHYL ALCOHOL. Ivanitskaya, L. V.; Nanobashvili, E. M.; Lyashenko, L. V. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 50: 367-72(May 1968). (In Russian).

Radiation-chemical transformation of potassium and ammonium thiocyanates in ethyl alcohol was studied as a function of various kinetic factors (concentration of solutions, gas properties, dosage, and anion properties). Alcohol solutions of the thiocyanates (0.001 to 0.1 m/l) were irradiated with 10^{16} to 10^{19} eV/ml · sec ^{60}Co γ doses. Sulfates and cyanides of corresponding alkali metals and in some cases organic rhodanates were the products of radiolysis. In the presence of oxygen a high yield, characteristic of chain processes, was obtained. (R.V.J.)

37806 FORMATION OF EXCITED STATES IN THE NANOSECOND-PULSE RADIOLYSIS OF SOLUTIONS OF BENZENE AND TOLUENE. Cooper, R.; Thomas, J. K. (Argonne National Lab., Ill.). J. Chem. Phys., 48: 5097-5102(June 1, 1968).

Short-lived species were observed via absorption in the 5000-Å region and fluorescence below 4000 Å in the nanosecond-pulse radiolysis of benzene and toluene. The decay of the absorption and fluorescence is first order with $t_{\frac{1}{2}} = 18.2 \pm 1.5$ nsec in benzene and $t_{\frac{1}{2}} = 21.6 \pm 1.5$ nsec in toluene. In benzene the fluorescence and absorption at 5150 Å was assigned to the $^1B_{2u}$ state. Solutions of biphenyl in benzene and toluene show only a low yield of negative and positive ions (~0.1), while solutions of naphthalene, anthracene, and biacetyl show large yields (G = 3 to 4) of triplet states. Naphthalene and anthracene quench the $^1B_{2u}$ of benzene, while at the same time, the characteristic fluorescence of naphthalene and anthracene are observed. The triplet states of these molecules are derived from the $^1B_{2u}$ and triplet ^3B state of benzene, the latter state having a $t_{\frac{1}{2}} \sim 20$ nsec. By using piperylene to preferentially scavenge triplet states in naphthalene–benzene solutions, the following G values are measured: $G(^1B_{2u}) = 1.62 \pm 0.28$ and $G(^3B) = 1.85 \pm 0.3$. Ionic scavengers such as methanol, nitrous oxide, and cyclohexene reduce the yield of the $^1B_{2u}$ state, while the $t_{\frac{1}{2}}$ remains unaffected. It is concluded that this state is derived from ion recombination, along with the triplet state. The yield of anthracene triplet is larger than naphthalene triplet, and from the effect of ionic scavengers and xenon on these solutions, it is concluded that the difference is due to a higher singlet state of benzene. This higher singlet, which may be the $^1E_{1u}$ state formed directly by the secondary electrons, is scavenged by anthracene but not by naphthalene. (auth)

37807 NANOSECOND-PULSE RADIOLYSIS OF ANILINE. Cooper, R.; Thomas, J. K. (Argonne National Lab., Ill.). J. Chem. Phys., 48: 5103-9(June 1, 1968).

The nanosecond-pulse radiolysis of pure aniline reveals two transient species absorbing at 3850 Å and 10,500 Å or higher. Each transient shows a rapid initial first-order decay ($t_{\frac{1}{2}} = 62.5 \pm 1.5$ nsec) and a long-lived (tens of microseconds) decay. In the presence of electron scavengers, the long-wavelength transient is removed, and yields of the negative ions of biphenyl

and pyrene are observed with plateau yields of G = 0.95 ± 0.05. At high concentrations of biphenyl or pyrene, the decay characteristics of the negative ions are identical with those of the species in pure aniline at 3850 Å. Scavenging studies using both positive and negative ion scavengers show that the two transients present in pure aniline are the solvent positive ion (3850 Å) and the solvated electron (10,500 Å) in aniline. The extinction coefficients of ϕNH_2^- and $e^-_{aniline}$ determined from ionic scavenging results are 12,050 and 3550 cm^2/mole, respectively. The formation of excited states of naphthalene, anthracene, and 1,2-benzanthracene are observed, and the results clearly show that, where solvent–solute charge-transfer reactions are possible, they lead to the production of ~20% of the total triplet yields. (auth)

37808 DETERMINATION OF THE YIELD OF LABELED HIGH-BOILING AND POLYMER PRODUCTS OF REACTIONS OF TRITIUM RECOIL ATOMS WITH HYDROCARBONS. Avdonina, E. N. Radiokhimiya, 9: 741-2(1967). (In Russian).

A simple method was developed for determining the activity of nonvolatile products of reaction between tritium recoil atoms and hydrocarbons in order to find the true yield of labeled products from the reaction. The design of a device for separating the specimen fractions is described and the ratio of the activity of nonvolatile, difficultly volatile, and liquid fractions of irradiated compounds was found. Combined with gas–liquid chromatography the method permitted the determination of absolute yields of polymer fractions and separate labeled compounds. Data obtained for pure benzene and pure cyclohexane showed 39, 8, and 53 for heavy polymer, light polymer, and liquid fraction of C_6H_6 and 9, 11, and 80 for C_6H_{12}, respectively. (R.V.J.)

37809 A METHOD FOR PRODUCING RADIOACTIVE TELLURIUM. (to Japan Atomic Energy Research Inst.). British Patent 1,118,859. July 3, 1968. Priority date Oct. 12, 1965, Japan.

In a method for the production of radioactive Te, an irradiated actinide element containing Te as a fission product is dissolved in an aqueous solution of a hydrohalic acid or thiocyanate; the Te is deposited from the solution by introduction of a metal selected from Ni, Cu, Bi, Hg, and Ag; the metal onto which the radioactive Te has deposited is separated; and the Te is recovered from the metal. The Te is separated from the metal by dissolving the metals in aqueous HNO_3, evaporating the solution to dryness, redissolving the residue in concentrated HCl, diluting the solution to 0.1 to 0.5 N with respect to HCl, passing the HCl solution through a cation exchange resin in its H form, and then eluting the adsorbed radioactive Te from the resin with 1 N HCl. (B.L.M.)

37810 METHOD FOR PRODUCING NITROGEN-CONTAINING TRIOXANE COPOLYMER. Ishida, Shinichi (to Asahi Chemical Industries Co., Ltd.). Japanese Patent 1967-16071. Sept. 2, 1967. Filed Jan. 23, 1964.

A method is described for producing a trioxane copolymer, which is very white and has good thermal stability. Trioxane is irradiated by an ionizing radiation in the presence of a small amount of maleic imide, maleic hydrazile, itaconic imide, or itaconic hydrazile, to polymerize it. (NSA of Japan)

37811 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XXIII. THE POLYMERIZATION OF VINYLENE CARBONATE. Hardy, Gy.; Nyitrai, K.; Cser, F.; Nagy, A. Magy. Kem. Foly., 74: 169-72 (Apr. 1968). (In Hungarian).

It is characteristic of the kinetical curve of the solid state polymerization of vinylene carbonate that after a linear period (up to 20% conversion) the rate of the reaction decreases for a while, then it becomes accelerated, thus at the end the conversion limit reaches about 70%. In the linear period the molecular weight of the polymer is independent of, but in the accelerating period increases with, the degree of conversion. The molecular weight distribution of the polymers was measured by the ultracentrifuge method and found to be more homodisperse in the linear period than in the accelerating one. The observable morphological changes during the polymerization were followed by polar optical investigations. (auth)

37812 RADIATION-INDUCED SUBSTITUTION OF AROMATIC COMPOUNDS IN DILUTE AQUEOUS SOLUTIONS. II. HYDROXYLATION OF ANISOLE. Fendler, J. H.; Gasowski, G. L. (Carnegie-Mellon Univ., Pittsburgh). J. Org. Chem., 33: 2755-7(July 1968). (RRL-2310-222).

Isomeric methoxyphenols and phenol have been quantitatively determined by gas–liquid partition chromatography in irradiated solutions of aqueous anisole. The mechanism for the radioinduced hydroxylation is discussed in terms of an initially formed methoxy-substituted hydroxycyclohexadienyl radical (I). Two radicals of I subsequently decompose to give one molecule of methoxyphenol, but the obtained G-values for methoxyphenols suggest preferential dimer formation. If oxygen is present, in addition to scavenging the solvated electron, it adds to I forming a peroxy radical whose subsequent decomposition alters the isomer distribution of the methoxyphenols. The radioinduced hydroxylation of anisole was compared with other hydroxylations initiated by γ rays and by chemical reagents. (auth)

37813 γ-RAY INDUCED ADDITION OF CHLORINATED METHANES TO CYCLIC OLEFINS. Schwarz, Alexander; Guesten, Hans; Schulte-Frohlinde, Dietrich (Kernforschungszentrum, Karlsruhe, Ger.). Chem. Ber., 101: 1601-13(1968). (In German).

In the γ radiolysis of cycloalkene–polychloromethane mixtures (CCl_4, $CHCl_3$, and CH_2Cl_2) at room temperature, mixtures of chlorinated saturated hydrocarbons and dimeric bicyclic olefins arise. In the cyclopentene–CCl_4 mixture, the 1 : 1 addition product 2-chloro-1-trichloromethylcyclopentane was obtained in the principal product. In the γ irradiation of cyclohexene–CCl_4 mixtures, the 1 : 1 addition product was not found, but trichloromethylcyclohexane was formed as the principal product. Some still unidentified compounds were prepared radiochemically. The G values of the radiolysis products are independent of the dose and output, but depend however on the molar composition of the mixture. The G values of the chlorinated hydrocarbons decrease in the series with CCl_4, $CHCl_3$, and CH_2Cl_2, and those of the bicyclic olefins remain almost constant in this series. For the disappearance of the olefins, the G values lie at 30. (tr-auth)

37814 ON A pH DEPENDENT INCREASE IN THE YIELD OF AVAILABLE RADICALS IN THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Marketos, D. G. (Nuclear Research Center, Democritos, Athens); Rakintzis, N. Th.; Stein, Gabriel. Z. Phys. Chem. (Frankfurt), 59: 177-88(May 1968).

Previous studies have indicated that Safranine T is oxidized in gamma-irradiated, aerated solutions by OH radicals but not by HO_2, O_2^- or H_2O_2. An increase in the apparent G(OH) is observed from a constant value ~2.6 above pH 3 to a constant value of ~3.2 below pH2. An increase in $G(H_2O_2)$ is also observed. The effects of scavengers: 2,5-dichlorohydroquinone, iodide ions, and hydrogen peroxide on this process was investigated. It is suggested that the primary yield of radicals in irradiated solutions is not itself affected by the change in pH, but that the number of available radicals is increased through inhibition of the recombination of radicals produced in pairs. (auth)

37815 IRRADIATED CROSS-LINKED POLYMERIC COMPOSITIONS. (to International Standard Electric Corp.). British Patent 1,117,565. June 19, 1968. Priority date Sept. 30, 1965, United States.

A process for the production of highly crosslinked poly(vinyl chloride) compositions consists of mixing poly(vinyl chloride) with a polyethylenically unsaturated ester, heating the mixture above the melting point of either component, forming the mixture into the desired shape, cooling the mixture, and subjecting the cooled mixture to 0.1 to 50 MRAD of high-energy electrons. The ester is selected from trimethylol propane trimethylacrylate, triallyl phosphite, polyethylene glycol dimethacrylate, and triethylene glycol dimethacrylate. (B.L.M.)

37816 IRRADIATION OF ELASTOMERIC COMPOUNDS. Gladstone, Harold M.; La Flamme, Paul M.; Reihsmann, Robert M.; Schoen, Herbert M. (to Quantum, Inc.). U. S. Patent 3,389,098. June 18, 1968. Filed Sept. 16, 1963.

The lubricity of vulcanized elastomers having residual carbon-carbon unsaturation is improved by treatment with acrylic acid in the presence of uv radiation, γ radiation, or heat in the presence of a thermal initiator, and heating with SF_4, a complex of SF_4 and BF_3, or a mixture of NaF and SCl_2. (Offic. Gaz.)

37817 PRODUCTION OF IRRADIATED MATERIAL. Derbyshire, Rodney L.; Schernig, Fred W. (to Raychem Corp.). U. S. Patent 3,387,065. June 4, 1968. Filed Mar. 3, 1966.

In a process of producing an irradiation crosslinked polymeric tube substantially free of minute holes, an electrical conductor substantially smaller in cross section than the interior of the tube is inserted within the tube substantially along its entire length. The conductor is connected to ground, and the tube is crosslinked by irradiation with electrons while the conductor is grounded. (Offic. Gaz.)

Radiochemistry

Refer also to abstracts 37709, 37760, and 37781.

37818 CHEMICAL EQUILIBRIA IN AMERICIUM AND CURIUM SULPHATE AND OXALATE SYSTEMS AND AN APPLICATION OF A LIQUID SCINTILLATION COUNTING METHOD. Aziz,

A.; Lyle, S. J.; Naqvi, S. J. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem., 30: 1013-18(May 1968).

Americium-241, curium-244 and, where necessary for purposes of comparison, europium-152 and -154, were used to measure equilibrium constants in aqueous sulphate and oxalate systems at an ionic strength of 0.5. Partition into a polystyrene-type 8 per cent cross-linked cation-exchange resin and/or into di-(2-ethylhexyl)-phosphoric acid in toluene was examined. 1:1 and 1:2 metal-ligand complexes were formed with both ligands, and information was obtained on the partition of monosulphate cations into the ion-exchanger. The application of liquid-scintillation counting to such partition studies with α-emitters, and the equilibrium constants obtained in this work are discussed. (auth)

37819 A STUDY OF THE STABILITY AND RADIOCHEMICAL PURITY OF SOME RADIOPHARMACEUTICALS. I. CALCULATIONS OF ABSORBED RADIATION ENERGY. Cifka, J.; Burianek, J. (Nuclear Research Inst., Rez, Czechoslovakia. State Inst. for Control of Drugs, Prague). J. Label. Compounds, 4: 107-18(Apr.-June 1968).

The radiation energy absorbed in solutions of phosphorus-32, iodine-125 and -131, mercury-197 and -203 was calculated and tabulated for various times of storage. The influence of geometrical shape of solutions was also evaluated. An experimental verification of calculations was carried out for solutions of iodine-131, the good agreement was obtained. The possibilities and limitations of the use of external gamma irradiation for estimating the self-radiation effect are discussed. (auth)

37820 CHEMICAL EFFECTS OF BROMINE ACTIVATED BY THE ISOMERIC TRANSITION $^{82m}Br \rightarrow {}^{82}Br$ IN BINARY ORGANIC MIXTURES. III. REACTIONS IN MIXTURES OF BROMOBENZENE WITH METHANOL AND WITH n-PROPYL BROMIDE. Stamouli, Maria L.; Katsanos, Nicholas A. (Democritus Nuclear Research Center, Aghia, Greece). Radiochim. Acta, 9: No. 1, 13-15(May 1968).

The chemical effects of the isomeric transition $^{82m}Br \rightarrow {}^{82}Br$ were studied in mixtures of varying composition of bromobenzene and methanol as well as in mixtures of bromobenzene and n-propyl bromide. The results are consistent with the previously suggested hypothesis that bromine activated by the above isomeric transition forms metastable complexes with both constituents of each mixture, these complexes being in equilibrium before they decompose unimolecularly to give ^{82}Br containing organic products. Comparison of the various equilibrium constants shows that in the complexes the excited and/or charged ^{82}Br is probably linked to the bromine atom of the bromides rather than to the whole molecule. (auth)

37821 CHEMICAL CHANGES IN THE β-DECAY OF RaE IN THE TRI-PARA-SULFAMOYLPHENYLBISMUTH COMPOUND. Gracheva, L. M.; Nefedov, V. D.; Grachev, S. A. Radiokhimiya, 9: 738-41(1967). (In Russian).

Previous studies of the influence of substituents in the para position of electron-donors of the type CH_3^-, CH_3O^-, and $C_2H_5O^-$ showed that the yield of polonium-type compounds, R_3PoX, which are the product of stabilized primary molecular ions formed by the $R_3{}^{210}Bi \xrightarrow{\beta} [R_3Po]^+$ reaction, is higher (72 to 75%) than in the case of phenyl derivatives (60%). Studies were made of the influence of substituents in the para position of electron acceptors, such as the sulfamoyl group SO_2NH_2, which produced an opposite effect on the yield of R_3PoX type compounds. (R.V.J.)

37822 CHEMICAL RESULTS OF THE BETA DECAY OF ^{131}Te IN HYDROCARBON SOLUTIONS OF ORGANOTELLURIDES. Catlett, Duane Stewart. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1967. 106p. (IS-T-176).

Thesis.

The chemical consequences of the β decay of ^{131}Te from two dialkyltellurides in hydrocarbon solvents were investigated. The decay of each of the tellurides, diethyltelluride and di-n-butyltellurides, was studied in five solvents, n-pentane, n-hexane, cyclopentane, benzene, and toluene. The normal dialkyltelluride was irradiated with thermal neutrons to produce the dialkyltelluride (^{131}Te), which was purified immediately and dissolved in the hydrocarbon solvent. The solution was allowed to stand for 4 days in order for the decay of ^{131}Te (and interfering activities) to occur. The analyses were performed by standard radio-gas chromatographic techniques. The major product in both studies was the alkyl iodide resulting from the β decay of the dialkyltelluride (^{131}Te), if the C-I bond were not to rupture. In the case of diethyltelluride the abundance of ethyl iodide was 90% in all of the solvents studied, while in the case of di-n-butyltelluride the abundance of 1-iodobutane was 70 to 79%. The other products are discussed in terms of the reaction of the free ^{131}I atom with fragments of the decomposed alkyl radical of the original telluride and the surrounding solvent molecules. In preliminary studies solutions of diethyltelluride in n-pentane were prepared, irradiated, and analyzed in order to determine if the $^{130}Te(n,\gamma)^{131}Te$ reaction or the reactor γ field would influence product distributions. Solutions at two concentrations, 0.1 M and 0.5 M, were irradiated at two different power levels, 4 and 5 MW(e). The product distribution was definitely dose dependent. After correcting to zero dose ($n,\gamma + \beta$-decay), the product distribution was compared to that of the β decay from a solution of diethyltelluride (^{131}Te) in n-pentane (β-decay only). In the former case the yield of iodoethane was 18% less, the total organic yield was 10% less, and the yields of those products resulting from the reaction of the ^{131}I atom with a solvent molecule were 8% more. (Disser. Abstr.)

Separation Processes

Refer also to abstracts 37640, 37661, 37706, 37709, 37755, 38137, and 38525.

37823 (ANL-Trans-619) [STUDY OF PROCESSES OF TREATMENT BY AQUEOUS METHOD: LABORATORY]. Semi-annual Report of the Chemistry Department, Center for Nuclear Studies at Fontenay-aux-Roses, Direction of Nuclear Materials and Fuels, December 1966-May 1967. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translation of Section 7, pp 136-236 of report CEA-N-856. 101p. Dep. CFSTI.

Topics covered include: influence of possible modifications in "graphite-gas" fuels on their chemical processing, oxidation and reduction of plutonium, boiling of aqueous solutions containing tributyl phosphate, plutonium oxalate precipitation, plutonium recovery cycle, processing of highly irradiated enriched uranium oxides, extraction disturbance tests, the Rapsodie irradiated fuel reprocessing plant, and purification of plutonium by trilaurylamine extraction. (M.C.G.)

37824 (ANL-Trans-626, pp 1-35) [STUDY OF PROCESSES OF TREATMENT BY AQUEOUS METHOD: PILOT PLANT]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 8, pp 238-72 of report CEA-N-856.

Filtration and decontamination studies for processing a Mo-U alloy are described. Purification of plutonium by trilaurylamine extraction is considered. Studies were also made of the operation of pulsed columns and of the construction of a trilaurylamine regeneration unit. (M.C.G.)

37825 (ANL-Trans-626, pp 36-58) [STUDY OF PROCESSES OF TREATMENT BY DRY METHOD]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 9, pp 274-97 of report CEA-N-856.

Treatment of U-Zr and U-Al alloys by the fluoride volatility process is described. Separation of U and Pu from mixtures of their hexafluorides is discussed. Decladding of fuel elements by magnesium melting was studied. (M.C.G.)

37826 (ANL-Trans-628, pp 51-128) [STUDY ON THE VITRIFICATION OF SOLUTIONS OF FISSION PRODUCTS]. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Translation of Section 11, pp 351-427 of report CEA-N-856.

Studies on the vitrification of concentrated solutions of fission products were made on various types of solutions and on solid residues from dry processing methods. With respect to solutions from the processing of slightly alloyed U, the principal studies were on the perfecting of an induction furnace of the inactive model for the Marcoule pilot plant under construction and on the determination of the utilization program of this furnace. The first test series on the induction furnace are described in detail. With this series of tests the installation became operative. The preparation of active glass blocks is described. The thermal and electrostatic phenomena produced during storage of these blocks are examined. In a study of vitrification of solutions from the processing of U-Mo alloys, two techniques, pot vitrification and continuous calcination and vitrification, were investigated. Adaptation of the pot procedure to this type of solution gave encouraging results, but difficulties were encountered. These include reaction of the frit with the additive suspension and with the molybdic solution, volatility of MoO_3, and corrosive character of the glass used. The processing of molybdic solutions by continuous calcination was carried out using sugar as an antiwarping agent. Insoluble fission products cause the formation of an adherent soft ring at the interior of the calcinator. A continuous vitrification operation was obtained for a week by associating an induction-heated fusion furnace with the calcinator. Solutions with a relatively high concentration of Al pose particular problems, which require new studies of glass and the adaptation of preparation procedures. The solutions from U-Al fuels can be vitrified after elimination of the

Hg introduced as dissolution catalyst. This elimination is done by fixation of the Hg on a Cu column using a discontinuous method. The optimum fixation conditions were determined. The adaptation of these glasses to a pot procedure was tested in a series of orientation studies. The most significant difficulty was the fusibility of the glass frit, necessarily richer in Al. Detailed data on the results obtained in each of these studies are tabulated and graphed. A technique for direct microdetermination of the apparent normal potential of the Ce(IV)–Ce(III) couple was developed, and errors caused by the miniaturization were measured. A potential of 1.1671 ± 0.0021 V was obtained in comparison with the standard calomel electrode. (J.S.R.)

37827 (BNWL–600) DISSOLUTION OF OXIDE-COATED ZIRCONIUM AND ZIRCONIUM ALLOYS IN AMMONIUM FLUORIDE–AMMONIUM NITRATE SOLUTIONS. Phillips, John F. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

Pitting or pinholing of oxide-coated Zircaloy-2 coupons was markedly more rapid and extensive when the coupons were exposed to boiling 7.5 to 8M $NH_4F-0.5M$ NH_4NO_3 than in similar exposure to the standard Zirflex dissolvent, 5.5M $NH_4F-0.5M$ NH_4NO_3. Attack by the more concentrated dissolvent was more uniform over the surface of the metal. There are several advantages of the more concentrated reagent over the standard Zirflex reagent. Oxide-coated Zircaloy-2 is more rapidly and extensively pitted. Terminal zirconium concentration in the declading solution can be reached more quickly. Higher terminal zirconium concentrations are possible. (auth)

37828 (BNWL–732) UNIDIRECTIONAL CESIUM LOADING, SCRUBBING, AND ELUTION OF AW500 ZEOLITE COLUMNS. Ames, L. L. Jr.; Mercer, B. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 33p. Dep. CFSTI.

Unidirectional flow operation of an AW500 synthetic zeolite column for cesium removal and recovery from Purex alkaline supernatant was shown to be feasible within the various flow rate ranges studied. The ranges included a downflow loading rate of 1.5 column volumes/hr, downflow scrubbing at 0.75 and 1.5 column volumes/hr with 0.2M $(NH_4)_2CO_3$ solution, and downflow elution at from 0.64 to 3.0 column volumes/hr with 2.0M NH_4OH + 3.0M $(NH_4)_2CO_3$ solution. Elution flow rates of more than 3 column volumes/hr were too rapid. (auth)

37829 (CEA-N–856, pp 57-70) TRAITEMENT DES EFFLUENTS MOYENNEMENT ET FAIBLEMENT ACTIFS. (Treatment of Moderately and Weakly Active Effluents). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The pilot plant at Saclay for ion-exchange decontamination of low-activity effluents (2 to 5×10^{-2} $Ci.m^{-3}$) is described. An example is given of the evolution of γ emitters during different phases of the treatment. The strontium carbonate process for treatment of effluents is schematized. This procedure was studied in order to eliminate the radioactive Sr. Preliminary results showed that in order to obtain good separation it is necessary to separate the effluents of chemical decladding that are rich in Mg. Use of cobalt ferrocyanide and manganese oxide hydrates for precipitation of radioelements present in evaporator concentrates was applied to Marcoule and to Fontenay-aux-Roses concentrates. A procedure was defined for biodegradation tests of detergents. The procedure is divided into the three steps: constitution of a bacterial bed, sensitization of the bed, and biodegradation. (J.S.R.)

37830 (CEA-N–856, pp 71-7) TRAITEMENT DE L'URANIUM. (Treatment of Uranium). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In the installation for processing of enriched uranium, the recovery of uranium with 30% enrichment in ^{235}U from Masurca wastes was improved by the homogenization of solutions before their reaction with nitric acid. The soda dissolver designed for the T mill for processing of enriched uranium can operate either continuously or in batch quantities, which will make it possible for the mill itself to be operated either in batch or continuous operation. The optimum conditions for production of frittable uranium dioxide beginning with uranium hexafluoride were determined for each of the three operational steps: precipitation of ammonium uranate, pyrohydrolysis of the diuranate, and reduction of the oxide U_3O_8. (J.S.R.)

37831 (CEA-N–856, pp 434-44) ETUDES DE TECHNOLOGIE ACTIVE. (Studies in Active Technology). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The installation for vitrification of fission products by the gel procedure in the Marcoule pilot plant for the processing of fuel elements has been in operation for three years. During this time repair of the components of the cell was made using remote-control devices. The repair techniques used, the transfer of tablets, and the processing of wastes, all by remote control, are described. The remote-control devices for repair and removal of large pieces of equipment are discussed. (J.S.R.)

37832 (CEA-R–3411) CONTRIBUTION A L'ETUDE DES ELEMENTS CIS- ET TRANS-URANIENS PAR CHROMATOGRAPHIE SUR PAPIER ET ELECTROPHORESE. (Study of Cis- and Trans-Uranium Elements by Paper Chromatography and Electrophoresis). Clanet, Frank (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). 1968. 131p. (In French). Dep.

Thesis. Submitted to Univ., Paris, France.

Application of paper chromatography and electrophoresis in inorganic chemistry was extended to elements 90 to 96 in hydrochloric and nitric acid solution. Results were obtained concerning the following points: (1) Characterization of the valency states of Np and of Pu using colored reactions on chromatograms and electropherograms. The valency IV was characterized by alizarin, arsenazo-I and thorin-I, but diphenylcarbazide was used for the hexavalent state. (2) Paper chromatography: by using as eluents, mixtures of equal parts of aqueous HCl and HNO_3 solutions and of alcohols (methanol, ethanol, and butanol), the R_f values of elements 90 to 96 were determined. It was possible to deduce certain conclusions concerning the complexing of these elements by Cl^- and NO_3^- ions. (3) An electrophoretic technique on cellulose acetate membranes was developed in order to separate the charged species formed by the elements 90 to 96 in HCl and HNO_3 solutions from 1 to 12 M. Mobility curves were obtained. It appears that the tendency for the elements considered to form anionic complexes follows the order of the ionic potentials when the valency state is four; this order is reversed for the valency three. The ions Cl^- have a smaller tendency to form complexes than the NO_3^- ions with respect to these elements in their oxidation state III or IV, but the reverse phenomenon is observed for U^{VI} and Pu^{VI} Finally, the complexing of the cations Pu^{4+} and PuO_2^{2+} by NO_3^- follows the order of the ionic potentials but occurs in the reverse order for Cl^- ions. (4) Various analytical applications are considered: separation of the various elements from each other and separation of the valency states of Np and of Pu. (auth)

37833 (CEA-R–3451) METHODE DE SEPARATION RAPIDE DU ZIRCONIUM ET DU NIOBIUM DE PERIODE COURTE A PARTIR DES PRODUITS DE FISSION. (Rapid Separation of Short Half-Life Niobium and Zirconium from Fission Products). Hubenthal, Karleinz; Benabed, Abderrahmane (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1968. 10p. (In French). Dep.

A method is described for rapidly separating ^{98}Zr (30 sec half-life) from fission products. The daughter activity ^{98}Nb (2.8 sec) is separated by milking from the Zr fixed on a cation exchange resin. (auth)

37834 (EUR–3452(Vol.2)) DECONTAMINATION DES EFFLUENTS PAR LES ZEOLITHES. (Decontamination of Effluents by Means of Zeolites). Verot, J.-L.; Blum, J.-M.; Sarfati, R.; Dagnes, J.; Cassin, Y. (Etablissements Kuhlmann, Paris (France)). May 1968. 80p. (In French). Dep.

The systematic research carried out previously on synthetic effluents was supplemented by tests on real effluents. These tests showed that the results were unchanged and also that the concentration factors obtained were 3 to 3.5 times as high as in conventional processing. In order to improve the decontaminating properties of zeolites in relation to strontium, a new zeolite and a method of synthesizing it were developed. The encouraging results obtained must be checked in effluents of varying concentrations. A micropilot unit was constructed for continuous testing of the substances studied. The influence of various parameters: pH value, flow, load, number of stages, etc. was analyzed in both synthetic and real effluents. It was found that in four or six stages of identical processing methods it was possible to reduce the simulated activity of an effluent from 1000 C/m^3 to a level of 10^{-5} to 10^{-6} C/m^3. Methods of treating loaded zeolites were also studied: cement, bitumen, and fusion. The two latter methods are the most advantageous. The volume reduction factors were very high, namely, 250 and 1000 respectively. Orientation tests concerning the fixation of certain critical radioelements (Ce, Co, Zn, Ra) by zeolites were carried out. This is a preliminary approach that has yielded certain valid results. (auth)

37835 (JPRS–45458) SOVIET STUDIES IN ANALYSIS OF ORGANOPHOSPHORUS COMPOUNDS AND SEPARATION OF U(IV) AND U(VI) IONS. Translated from Zh. Anal. Khim., 23: 407-10; 455-7; 468-70(1968). 14p. CFSTI.

Translations of three papers are presented. Elements analysis of unstable organophosphorus compounds, separation of U(VI) from U(IV), and determination of phosphorus in organic compounds are the topics covered. A separate abstract was prepared for one paper that appeared originally as NSA 22: 23105. (M.C.G.)

For an abstract of the individual paper see: 37836.

37836 (JPRS-45458, pp 6-10) SEPARATION OF URANIUM(VI) AND URANIUM(IV) IN SULFO-CATION EXCHANGERS CONTAINING VARIOUS AMOUNTS OF DIVINYL BENZENE. Karalova, Z. K.; Shibaeva, N. P.; Pyzhova, Z. I. Translated from Zh. Anal. Khim., 23: 455-7(1968).

An abstract of this paper was prepared from the original language and appeared as NSA 22: 23105.

37837 (K-1744) ORGDP FUEL REPROCESSING STUDIES. Summary Progress Report, July-December 1967. Pashley, J. H.; Schappel, R. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 17, 1968. 66p. Dep. CFSTI.

The Oak Ridge Gaseous Diffusion Plant Gaseous Diffusion Development Division is participating in studies of a group of processes aimed at purifying and recovering valuable uranium and plutonium from spent nuclear reactor fuels. The program includes two main phases: preparation of conceptual plant studies with concomitant definition of problem areas associated with the process technology and plant design; and component development, including scale-up and testing of crucial process equipment and auxiliaries. Topics covered include: the status of the current low-enrichment fuel flow sheet studies, including the systems analysis project and conceptual plant studies; the contamination of plutonium product with ruthenium; plutonium hexafluoride alpha decomposition; tests in the semiworks plant; outlet gas filter studies; uranium product purification in a sorption-desorption system employing sodium fluoride; testing of the ORGDP designed peripheral compressor; and liquid bromine pentafluoride spill tests. (auth)

37838 (ORNL-4267) THE STACKED-CLONE CONTACTOR: A HIGH-PERFORMANCE SOLVENT EXTRACTION MACHINE HAVING POTENTIAL FOR USE IN THE PROCESSING OF HIGHLY RADIOACTIVE NUCLEAR FUELS. Groenier, W. S.; Whatley, M. E. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 48p. Dep. CFSTI.

The stacked-clone solvent extraction contactor has developed into a machine of high performance. The basic principles of operation were demonstrated to be valid. Both experimental and prototype models were built and operated; three sizes of experimental models have been tested; and a scale-up concept evolved. Future scaled-up versions will probably have contact times of less than 1 sec per stage at a reasonable flow capacity and at stage mass-transfer efficiencies greater than 70%. The rapid response of the contactor would allow a short turnaround time between campaigns. Its most promising application involves the processing of very highly radioactive nuclear fuels. (auth)

37839 (ORNL-TM-2227) ENGINEERING DEVELOPMENT OF CONTINUOUS SOL-GEL EQUIPMENT FOR PREPARING UO_2 SOLS BY PRECIPITATION-PEPTIZATION PROCESSES. Haas, P. A. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 49p. Dep. CFSTI.

Engineering development studies of continuous equipment for preparing UO_2 sols by precipitation-washing-peptization processes are summarized. Many operational problems were solved, and stable UO_2 sols of various desired chemical compositions were successfully prepared. In comparison with the batch-type operations, the continuous methods of precipitation, washing and dispersion exerted no apparent effects on the control of chemical compositions. However, the sol products from the continuous vacuum evaporator were not identical to those from the batch equipment, and determination of the optimum conditions for forming these sols into UO_2 spheres would require further study. The major problems involved the control and the mechanical dependability of the continuous operations. The transfers of the precipitates were the major sources of operational difficulty. Also, the sol concentration from the equipment was not as high as desired. Although acceptable dependability for use in remote operation was not demonstrated in most tests, the last one did demonstrate marginal acceptability. However, following this last test, studies of continuous precipitation processes were discontinued in order to concentrate the development effort on the more promising solvent extraction processes for UO_2 sol preparation. (auth)

37840 EXTRACTION BY ORGANIC SOLVENTS IN HYDROMETALLURGY OF TUNGSTEN, MOLYBDENUM, AND RHENIUM. Zelikman, A. N. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 3, 85-95(1968). (In Russian).

Results of investigations of extraction techniques for selective obtaining of molybdenum and rhenium from production solutions and separating of molybdenum from tungsten during tungsten-molybdenum concentrate processing are presented. The technique suggested involves initial extraction of molybdenum with esters of bis(2-ethylhexyl)phosphoric acid (DEHPA) and pH = 2. Rhenium is extracted with trioctylamine at the same pH. Molybdenum and rhenium are extracted from the respective organic phases with 7 to 10% NH_3 water. For the sake of avoiding the amine salt precipitation it is recommended that tributyl phosphate be added to the organic phase. The mechanism of molybdenum extraction with DEHPA is discussed. The effects of a number of anions and cations on extractability of molybdenum are discussed. For the purpose of separating molybdenum from tungsten the use of an acid-extraction technique involving extraction of molybdenum from acid pulps of tungstic acid with acetophenone is suggested. (auth)

37841 INFLUENCE OF VARIOUS TYPES OF ANIONIC COLLECTOR ON FLOTATION SEPARATION OF TUNGSTEN AND METALLIC IRON. Pol'kin, S. I.; Saksaganskaya, I. P.; Revazashvili, I. B. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 3, 96-100(1968). (In Russian).

The floatability of Fe and WC powders under different conditions was investigated. Changes in the energy states of their surfaces together with the change of relationship of different forms of oleic acid were found to be the main factors influencing floatability of these powders. The anionic collector selectively floated WC from iron in the alkaline medium in the presence of sodium silicofluoride. The recovery of iron from industrial powdered waste to tailings was 85 to 65%. (auth)

37842 IMPROVEMENTS IN OR RELATING TO THE REMOVAL OF RUTHENIUM FROM SOLUTIONS. Auchapt, Jacqueline; Fernandez, Nicolas (to Commissariat a l'Energie Atomique). British Patent 1,119,505. July 10, 1968. Priority date Dec. 31, 1964, France.

A process for decontamination by removal of Ru from solutions, which is particularly but not exclusively applicable to the Ru decontamination of effluents obtained from the treatment of irradiated fuels, is described. The process consists of adjusting the pH of a solution containing Ru to a value of not more than 2, adding periodate and/or paraperiodate ions to the solution and agitating it and adding lead ions at a temperature and pH so as to form a precipitate of lead periodate and/or paraperiodate entraining the Ru. (P.C.H.)

37843 SEPARATION OF URANIUM FROM NOBLE AND REFRACTORY METALS. (to United States Atomic Energy Commission). British Patent 1,119,598. July 10, 1968. Priority date Feb. 8, 1966, United States.

The process consists of adding the irradiated nuclear reactor fuel or reactor blanket material from which the rare earth fission products and plutonium values have already been removed to a molten Cu-Mg alloy. The Mg content is adjusted to 4 to 8 wt % of the alloy containing the fission products and U, and the alloy is contacted with a molten alkali or alkaline earth chloride salt which selectively oxidizes the U to uranium chloride which is soluble in the molten salt and which dissolves therein. The molten salt is in turn brought into contact with a molten Mg-Zn alloy which acts as a scrubber solution and which reduces the uranium chloride to metallic uranium which has a low solubility in the molten Mg-Zn alloy and precipitates out and as such may easily be recovered from the alloy. (P.C.H.)

37844 RADIOCHEMICAL SEPARATION BY THE RING OVEN TECHNIQUE. III. THE SYSTEMS $^{90}Sr/^{90}Y$, AND $^{140}Ba/^{140}La$. Klockow, D. (Univ., Freiburg i. B.). Talanta, 15: 541-5 (June 1968). (In German).

Rapid separations of ^{90}Y from ^{90}Sr and of ^{140}La from ^{140}Ba on carboxymethylcellulose filter papers by the ring-oven technique are described. Highest yields (>99% for ^{90}Y and ~90% for ^{140}La) and decontamination factors (5×10^3 to 10^4 for ^{90}Y and 10^3 for ^{140}La) were obtained by using EDTA as complexing agent and water for washing. The half-lives of the daughter-nuclides were found to be 64.7 ± 0.3 hr and 40.5 ± 0.2 hr for ^{90}Y and for ^{140}La respectively. ^{90}Y can be selectively separated with 85 to 90% efficiency from a mixture of all four nuclides by using a 1% solution of hydroxyisobutyric acid at pH 4.8 as eluting agent. (auth) (UK)

37845 METAL ION SEPARATIONS USING CELLULOSE PHOSPHATE AS AN ION-EXCHANGER. Schmitt, Donald H.; Fritz, James S. (Iowa State Univ., Ames). Talanta, 15: 515-24(June 1968). (IS-1649).

Cellulose phosphate was used as a chelating ion-exchanger to effect the separation of several metal ions. Its exchange rate is much more rapid than that of a chelating ion-exchanger con-

taining phosphonic acid groups on a polystyrene matrix. Weight distribution coefficients as a function of hydrogen ion concentration on cellulose phosphate are given for several metal ions. Successful separations of rare earths and alkaline earths, alkaline earths and alkali metals, and aluminium and alkaline earths were achieved on cellulose phosphate columns. (auth) (UK)

37846 ^{113m}In EMULSION BY MEANS OF COMPLEXING RESINS. Denni, R.; Adloff, J. P. (Centre de Recherches Nucleaires, Strasbourg). J. Inorg. Nucl. Chem., 30: 1112-15 (May 1968). (In French).

Indium 113^m is a radioactive indicator employed in biology and medicine by reason of its short half-life of 1.7 hr and its gamma radiation of 390 keV, which permits easy location. It is obtained from its parent ^{113}Sn. Two methods of separating the ^{113m}In are described, based on the use of resins of the aminodiacetate and phosphonate types. The product is stated to be of better radiochemical purity than when anionic resins are used, and equal to that when using zirconium oxide. (UK)

37847 SEPARATION OF LANTHANUM FROM BARIUM BY SOLVENT EXTRACTION WITH THE MONOOCYTL ESTER OF ANILINOBENZYLPHOSPHONIC ACID. Jagodic, V.; Herak, M. J.; Radosevic, J. (Rudjer Boskovic Inst., Zagreb). J. Less-Common Metals, 15: 371-5(Aug. 1968).

The extraction of the radionuclides ^{131}Ba and ^{140}La from hydrochloric acid solution by means of the monooctyl ester of anilinobenzylphosphonic acid (MOABP) has been studied. Solutions of MOABP in three different solvents (petroleum ether, carbon tetrachloride, and chloroform) were used as the organic phase and the influence of the solvents on the extraction of barium and lanthanum is discussed. It was found that lanthanum can be quantitatively extracted from certain hydrochloric acid solutions into the organic phase, whereas barium remains in the aqueous layer. A simple procedure for their separation is described. It can be carried out regardless of whether the metals are in dilute solution or in a carrier-free form. Barium chloride, even in high concentrations, does not influence the extraction of lanthanum. Lanthanum was re-extracted from the organic phase with 1 M hydrochloric acid. The purity of the separated lanthanum was checked by following its decay curve. (auth)

37848 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. PART II. SEPARATION OF ZIRCONIUM FROM IRON, ALUMINUM, CHROMIUM, AND OTHER ELEMENTS. Volkov, I. I.; Ostroumov, E. A. (Inst. of Oceanology, Moscow). Zh. Anal. Khim., 23: 863-7(June 1968). (In Russian).

Cinnamic acid quantitatively precipitates zirconium from an acid solution with pH of 2 on heating. The presence of large amounts of ammonium salts does not interfere. The precipitation of zirconium with cinnamic acid under these conditions permits its separation from Al, Cr, In, Ga, Be, U, rare earth elements, and Fe after its reduction to Fe(II) (auth)

37849 SEPARATION OF PROTACTINIUM FROM NIOBIUM, TANTALUM, AND ZIRCONIUM. Palshin, E. S.; Myasoedov, B. F.; Ivanova, L. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 872-6(June 1968). (In Russian).

A study was made of protactinium precipitation by hydrogen peroxide from a mixture of oxalic and hydrochloric acids and its separation from niobium, tantalum, and zirconium. Protactinium is precipitated quantitatively from $H_2C_2O_4$ solutions containing 7.5% of H_2O_2 and more than 1 N HCl. Under these conditions niobium, tantalum, and zirconium remain in the solution. (auth)

37850 ION EXCHANGE CONCENTRATION OF THORIUM ISOTOPES WITH SIMULTANEOUS SEPARATION FROM URANIUM. Karalova, Z. K.; Pyzhova, Z. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 940-2(June 1968). (In Russian).

A method is described for concentrating ^{230}Th from a sulfuric acid solution containing 1,000,000-fold amounts of uranium. The method is based on the adsorption of ^{230}Th by the KU-2 × 15 cation exchange resin from 1 N H_2SO_4. Uranium passes through the column into the filtrate. (auth)

37851 THIN-LAYER CHROMATOGRAPHY IN INORGANIC ANALYSIS. PART 3. SEPARATION OF URANIUM AND PLUTONIUM FROM TRANSPLUTONIUM ELEMENTS. Volynets, M. P.; Guseva, L. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 497-50(June 1968). (In Russian).

The separation of uranium from plutonium(IV) and transplutonium elements at the quantitative ratios of U : Pu = 500 : 1 and U : Am = 20,000 : 1 was carried out by the method of ascending thin-layer chromatography on silica gel from 0.02 ml of a 1 M $HClO_4$ solution using as solvent a mixture tributyl phosphate–benzene at a ratio of 1 : 1. The possibility of separating transplutonium elements from plutonium in the presence of 1 M HNO_3 with the use of a mobile solvent mixture tributyl phosphate–benzene (1 : 10) was investigated. (auth)

37852 THE USE OF CHITIN IN THE CHROMATOGRAPHIC SEPARATION OF UO_2^{2+} FROM Fe^{3+}, Ca^{2+}, AND Mg^{2+}. Glowacka, Danuta; Popowicz, Juliusz (Zaklad Chemii Ogolnej, Bialymstoku, Poland). Rocz. Akad. Med. Bialymstoku, 11: 47-51(1965). (In Polish).

A method using pulverized chitin, obtained from crayfish shells, was developed for the separation of UO_2^{2+} from Fe^{3+}, Ca^{2+}, and Mg^{2+}. A column 400 mm by 7 mm was prepared with water; 1 ml fractions were collected, the eluting agent was 0.005N HCl for the first 40 ml and 1N HCl for the remaining 20 ml. The time to collect one fraction was 30 min. Elution of Ca and Mg was complete in 20 fractions, while UO_2^{+2} eluted between the 25th and 35th fractions. Strong acid was necessary to remove Fe. These ions could not be separated on a column of cellulose under identical conditions. (BBB)

37853 PROCESS HEATING VIA COMBUSTION. Buckham, J. A.; Horn, S. J.; Legler, B. M.; Thompson, T. K.; Wheeler, B. R. (Idaho Nuclear Corp., Idaho Falls). Chem. Eng. Progr., 64: No. 7, 52-7(July 1968).

Results of a study of in-bed combustion to provide heat for an endothermic calcination process are reported. Tests were carried out in an existing facility for calcining radioactive wastes. Combustion temperatures were reduced by 200°C by injecting nitrate solutions into the fluidized bed during combustion, and fluidizing velocities were controlled at the desired value of about 1.0 ft/sec by use of oxygen-rich fluidizing air. (auth)

37854 IN-BED HEAT EXCHANGERS. Petrie, J. C.; Freeby, W. A.; Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). Chem. Eng. Progr., 64: No. 7, 45-51(July 1968).

A correlation is presented of heat transfer data for heat transfer from several in-bed horizontal multiple-tube heat exchangers, used at the Idaho Chemical Processing Plant, in the operation of a radioactive waste processing plant. The correlation shows that the heat transfer coefficient is inversely related to the particle diameter and the tube diameter, and is directly related to the reduced fluidizing mass velocity. The reduced fluidizing mass velocity replaces the conventional Reynolds number normally used in heat transfer calculations. (auth)

37855 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. COMMUNICATION 12. SEPARATION AND DETERMINATIONS OF METALS. Ostroumov, E. A.; Volkov, I. I. (Inst. of Oceanology, Moscow). Zh. Anal. Khim., 23: 973-9(July 1968). (In Russian).

Ammonium cinnamate precipitates iron, aluminum, chromium, titanium, zirconium, thorium, indium, gallium, beryllium, uranium, scandium, yttrium, and rare earth elements as basic and neutral cinnamates on heating, and thus these elements can be separated from manganese, nickel, cobalt, zinc, calcium, and magnesium. Rare earth elements and beryllium are separated as salts of a constant composition and can be determined by weighing these salts. By precipitating with cinnamic acid from an acid solution it is possible to separate titantium from iron, aluminum, chromium, indium, beryllium, and uranium; zirconium from iron, aluminum, chromium, indium, gallium, beryllium, uranium, and rare earths; scandium from rare earths. (auth)

37856 STUDY ON MACROPOROUS CATION EXCHANGE RESINS IN THE VIEW OF THE APPLICATION FOR ION EXCHANGE CHROMATOGRAPHY. Alexa, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 33: 1933-9(June 1968).

Properties of macroporous resins for use in ion exchange chromatography were studied by Eu–Pm separations. Data are presented in tables and graphs. (M.C.G.)

37857 FLUORIDE ADSORPTION BY THORIUM OXIDE IN AQUEOUS THORIUM NITRATE SOLUTIONS. Kispert, R. C.; Kato, T. R. (to United States Atomic Energy Commission). U. S. Patent 3,394,996. July 30, 1968.

A method is described for removing fluoride from aqueous solutions of thorium nitrate by contacting the solution with finely divided thoria, which has been calcined to a temperature not in excess of 900°F, to produce sorption of fluoride ion at a ThO_2/F mole ratio of at least 14 : 1. (AEC)

37858 AUGMENTING THE SEPARATION OF ADJACENT PAIRS OF RARE EARTHS IN ELUTIONS WITH HYDROXYETHYLETHYLENEDIAMINETRIACETATE (HEDTA). Powell, J. E.; Burkholder, H. R. (Ames Lab., Iowa). J. Chromatogr., 36: 99-104(July 23, 1968). (IS-1788).

Rare earth mixtures were eluted with ammonium HEDTA at

92°C with substantial gains in the separation of Er–Ho, Ho–Dy, Dy–Tb, and Tb–Gd pairs. Individual stability constants at 92°C were derived from the observed separation factors, and a simple mechanism was proposed to account for a drastic drop in chelate stability which occurs when only the lighter rare earth chelate species are heated from 15° to 92°C. A scheme for economical recovery of pure yttrium from yttrium–lanthanide mixtures is discussed. (auth)

37859 ADSORPTION OF CALCIUM AND STRONTIUM BY CRANDALLITE. Kunishi, H. M.; Taylor, A. W. (Dept. of Agriculture, Beltsville, Md.). Soil Sci. Soc. Amer., Proc., 32: 441-2(May-June 1968).

Samples of the phosphate mineral crandallite, $CaAl_3((P_4)_2(OH)_5 \cdot H_2O$ were equilibrated with solutions containing calcium and strontium chlorides labeled with ^{45}Ca and ^{85}Sr. The apparent selectivity coefficient for the equilibrium system, calculated from the isotopic dilution, varied from 1.5 at pH 9.3 to 8.2 at pH 4.7. The mineral has limited value as a scavenging agent for the removal of strontium from soil. (auth)

37860 METHOD OF SEPARATION OF THE BORON ISOTOPES. Chemla, Marius; Dirian, Gregoire; Perie, Michele (to Commissariat a l'Energie Atomique). British Patent 1,118,533. July 3, 1968. Priority date June 24, 1965, France.

The ^{10}B and ^{11}B isotopes can be separated by a chemical exchange process using a boric ester in vapor form flowing countercurrent to a solution of a metal borate in a liquid-vapor contact column. The metal borate is an alkali metal or alkaline earth metal borate, and the boric ester is either methyl or ethyl borate. The boric ester is condensed at the top of the contact column, and the condensed liquid is saponified by an alkaline water-alcohol solution. The metal borate solution is withdrawn from the column and acidified with H_3PO_4 to liberate the boric acid, which is then esterified to form the boric ester. (B.L.M.)

37861 METHOD FOR SOLIDIFYING RADIOACTIVE LIQUID WASTE. Sakata, Sadahiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-15519. Aug. 26, 1967. Filed Mar. 23, 1964.

An easy method is proposed for solidifying high-level radioactive liquid waste by means of vitreous substance. Glass fiber is pressed and then shaped into a plate. The end of this plate is dipped in the radioactive liquid waste, and dry or heated air is flowed around the plate (if necessary the plate may be directly heated). The radioactive material (in the liquid) is retained in the glass-fiber plate, and the plate is then fired at a temperature near the glass melting point. In consequence, the (retained) radioactive material as the oxide is covered by the glass. (NSA of Japan)

37862 INFLUENCE OF THE CHARGE ON PLUTONIUM ON THE EXTRACTION FROM NITRIC ACID OF THORIUM AND SOME FISSION PRODUCTS BY TRIDODECYLAMINE (TRILAURYLAMINE). Tsujino, Takeshi; Bathellier, Andre; Chesne, Andre (CEA, Fontenay-aux-Roses, France). Radiochim. Acta, 9: No. 1, 16-22(May 1968). (In French).

The decrease of the distribution coefficients (Kd) of nitric acid, thorium (UX_1), and fission products ($^{95}Zr–^{95}Nb$, $^{106}Ru–^{106}Rh$) in the mixture of trilaurylamine nitrate/xylol was studied as a function of the content of Pu in the solvent (0–90% of the saturation in the amine). A mechanism of the extraction process is given on the basis of the experimental results. The decrease of the distribution coefficients for nitric acid and thorium is directly related to the decrease of trilaurylamine nitrate, which forms a complex with Pu during the extraction. The observed decrease of the distribution coefficients for the fission products was greater than could be expected on account of the decrease of trilaurylamine nitrate in the solvent. The salting-out effect of Pu in aqueous solutions proved to be negligibly small in all these investigations. It is possible that these findings, when applied in connection with a continuous extraction process, will improve the decontamination of Pu during its purification process by extraction into TLA. (auth)

37863 COMPOSITION OF COMPLEXES OF NIOBIUM(V), FORMED DURING EXTRACTION WITH TRIBUTYL PHOSPHATE. Startsev, V. N.; Sannikov, Yu. I.; Stroganov, S. S.; Krylov, E. I. Zh. Neorg. Khim., 13: 1608-10(June 1968). (In Russian).

By means of physicochemical analysis methods it was shown that niobium is extracted from hydrochloric acid solutions in the form of the complex $H_2[NbO(OH)Cl_4]$. By infrared spectroscopic methods it was established that during extraction of niobium from hydrochloric acid solutions with TBP a part of the molecules of the organic solvent are found in the cation part of the compound being extracted, which represents the solvated ion of the oxonium, and the anion part is the solvated TBP of the anion $[NbO(OH)Cl_4]^{2-}$. The constant for the formation of the complex $[H_3O \cdot TBP]_2^+[Nb\overset{OH}{\underset{Cl_4}{}}\cdot TBP]^{2-}$ was determined by extrapolation of the function $(\lg K_p - 3 \lg c_{TBP}) - \lg c_{Cl}$ and found to be equal to 0.016. By analysis of the equation for the formation of complexes of niobium and titanium with TBP, the conditions for the possible separation of these metals in the hydrochloric acid solution of the metals–TBP system were described. (tr-auth)

37864 METHOD OF SEPARATING UF_6 FROM BROMINE FLUORIDES. (to United States Atomic Energy Commission). British Patent 1,117,969. June 26, 1968. Priority date Nov. 15, 1966, United States.

A mixture of gases containing UF_6 to be separated is contacted with NaF at a temperature of 100 to 175°C at which UF_6 is adsorbed on the NaF and then the UF_6 is removed from the NaF by volatilization. If BrF_3 is present in the gaseous mixture, the mixture is contacted with F_2 in an amount sufficient to convert the BrF_3 to BrF_5 prior to removal of the UF_6 with NaF. (B.L.M.)

37865 ISOTOPE SEPARATION PROCESS. (to CIBA Ltd.). British Patent 1,118,896. July 3, 1968. Priority date Feb. 18, 1966, Switzerland.

A process for concentrating natural heavy isotopes of O, N, and C consists of fractional distillation of an azeotropic mixture of methane and nitric oxide. The distillation is carried out at 106 to 109°K at a pressure in the range of 500 to 600 mm of Hg. (B.L.M.)

37866 ION-EXCHANGE SEPARATION OF ALKALI METAL IONS FROM POLYVALENT CATIONS AND THEIR DETERMINATION IN SILICATE ORES. Ganapathy Iyer, S.; Krishnan, C. V.; Venkateswarlu, Ch. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 6: 277-8(1968).

Alkali metals, viz. Li, Na, K, Rb, and Cs were separated together from Mg, Ca, Sr, Ba, Mn, Cu, Co, Ni, Zn, Fe, Al, Th, U, and rare earths by a simple ion exchange procedure using a weak cation exchanger, Zeokarb-226. The procedure was applied to the separation of alkali metals in silicate ores, prior to their flame spectrophotometric determination. (auth)

37867 PARAMETER INVESTIGATION FOR ALKALI METAL SEPARATION ON SEPHADEX COLUMNS. Ortner, H.; Spitzy, H. (Technische Hochschule, Graz). Z. Anal. Chem., 238: 167-82 (1968). (In German).

The application of 75% (v/v) methanol as best eluant for alkali separation on Sephadex columns is described. Sephadex G-25 fine proves to be the most suitable gel material for this purpose. The following parameters are of great influence on the alkali separation on Sephadex G-25 columns with 75% (v/v) methanol as eluant: particle shape and size, pH, flow rate, alkali concentration, and temperature. They were investigated systematically to find the most favorable conditions for the alkali separation by optimal parameter combination. (auth)

37868 THE STATUS OF RADIOACTIVE WASTE MANAGEMENT OF TAIWAN. Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Hoken Butsuri, 3: 223-33(Mar. 1968).

The present status of radioactive waste management on Taiwan is described. Emphasis is placed on the facilities, methods of waste treatment, and the quantities of waste disposed from 1962 to 1966. Some particular experiments related to the improvement of waste disposal are given. Future development and the description of a prospective waste management center on Taiwan are also included. (NSA of Japan)

37869 RECOVERY OF TELLURIC ACID FROM ^{131}I PRODUCTION LIQUID WASTE BY MODIFIED ALCOHOL PRECIPITATING METHOD. Hwang, Yin-si; Huang, An-i (National Tsing Hua Univ., Hsinchu, Taiwan). Hoken Butsuri, 3: 234-5(Mar. 1968).

Telluric acid can be recovered from ^{131}I production liquid waste. The waste was alkalized with ammonium hydroxide and precipitated with alcohol. The crude ammonium tellurate precipitate can be turned to telluric acid by recrystallizing from HNO_3. Spectrophotometric and chemical analysis of telluric acid showed that the purity of recovered telluric acid was satisfactory. The recovered telluric acid was reused, and showed the yield of ^{131}I from recovered telluric acid was the same as from original Cica C.P. grade telluric acid. (NSA of Japan)

37870 SEPARATION OF LANTHANIDES AND ACTINIDES ON ION EXCHANGERS USING HYDROXYETHYLENEDIAMINETRIACETIC ACID. IV. THE FORMATION OF A NEGATIVE COMPLEX OF THE TYPE $MeY_2H_5^{(5-a)-}$ BETWEEN THE LANTHANIDES AND HEDTA. Merciny, E.; Duyckaerts, G. (Univ., Liege). J. Chromatogr., 35: 549-61(July 2, 1968). (In French).

The nature of the complexes formed between the lanthanides and HEDTA was studied by electrochromatography and adsorption on an anionic resin. It was found that above a certain pH value, which

is characteristic for the element considered, a negative complex of the type $MeY_nH^{(3-a)-}$ is formed between the rare earths and the complexing agent. The existence of this new complex makes it possible to interpret certain apparent anomalies in the elution curves of the rare earths obtained on a cation exchanger with hydroxyethylenediaminetriacetic acid. (auth)

37871 PROCESS FOR THE PURIFICATION OF INDUSTRIAL SOLUTIONS OF HAFNIUM AND ZIRCONIUM SALT. De Calmes, Alain; Humeau, Henri; Pilon, Robert; Rivoallon, Jean (to Commissariat a l'Energie Atomique). British Patent 1,117,457. June 19, 1968. Priority date Dec. 7, 1964, France.

A process for removing impurities, particularly P and Ti, from solutions of $Hf(NO_3)_4$ and/or $Zr(NO_3)_4$ includes diluting the solution to 1.5N nitrate, passing the solution through a cation resin column to fix the Hf and/or Zr, traces of phosphates, and the Ti with other impurities passing through with the effluent. The Ti is eluted from the column with 1.5N HNO_3, and the Hf and/or Zr is eluted with 1.5 to 3N H_2SO_4. The last traces of P as phosphates are eliminated by standing and decantation in the H_2SO_4 elution solution. (B.L.M.)

37872 PROCESS FOR STRIPPING ACTINIDES CONTAINED IN ORGANIC SOLVENTS. Bathellier, Andre (to Commissariat a l'Energie Atomique). British Patent 1,117,385. June 19, 1968. Priority date Sept. 17, 1965, France.

A process is described for stripping the actinides, U, Np, and Pu, from an organic solvent, TBP or trilaurylamine, that results from a solvent extraction process. The organic solvent is contacted with nitrous acid, which is introduced into the aqueous stripping solution in the form of nitric oxide contacted with an aqueous nitric acid solution maintained out of contact with air. (B.L.M.)

37873 PROCESS FOR EXTRACTING THORIUM AND RARE EARTHS. Hansen, Robert D. (to Dow Chemical Co.). U. S. Patent 3,378,352. Apr. 16, 1968. Filed Dec. 15, 1965.

A solvent extraction process for recovery and separation of Th and rare earth values from acidic aqueous solutions also containing a relatively large concentration of Fe^{3+} consists of contacting the aqueous solution with a substantially water-immiscible liquid organic extractant to preferentially extract Th and the rare earths. The extractant is a mixture of a dialkyl-substituted orthophosphoric acid and a second phosphonyl group-containing member. After separation of the phases, the Th and rare earths are separated by contacting the organic extract with either HCl or HNO_3 to strip the rare earth values into the acid phase. (Offic. Gaz.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 37657, 37868, 37944, and 38122.

37874 (64-RL-3635M) TECHNIQUES FOR GEOLOGICAL DATING OF MINERALS BY CHEMICAL ETCHING OF FISSION FRAGMENT TRACKS. Fleischer, R. L.; Price, P. B. (General Electric Co., Schenectady, N. Y. Research and Development Center). Apr. 1964. 20p. Dep. CFSTI.

Experiments on mica and natural glasses have shown that the number of irradiation damage tracks created by spontaneous fission of uranium atoms in these materials is a useful measure of geological time. To extend this technique to other minerals it is necessary to be able to observe and identify fission tracks. Suitable chemical etching treatments are described for revealing such tracks in a variety of minerals, and rules are given for distinguishing fission tracks from dislocations and other defects. Dating results are given for two hornblendes and an apatite as examples of the procedures. Track studies also give a sensitive measure of the present and past distribution of uranium atoms in minerals. (auth)

37875 (DP-MS-66-81) IRON, MANGANESE, COBALT, AND ZINC CYCLES IN A SOUTHEASTERN RESERVOIR LAKE. Marshall, J. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 5, 1967. Contract AT(07-2)-1. 12p. (CONF-670503-30). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The cycles of cobalt, iron, manganese, and zinc in Par Pond on the site of the Savannah River Plant were studied. The concentrations of these elements in lakewater solutions, seston, net plankton, preserved and unpreserved trapped deposits, and consolidated and unconsolidated sediments at several depths are determined monthly. The sorption of ^{59}Fe, ^{54}Mn, ^{57}Co, and ^{65}Zn by seston was determined at several depths and the results are presented. (J.C.W.)

37876 (ORO-490-12a) INFLUENCE OF SEDIMENTS ON THE TRANSPORT OF SOLUTES. Shih, C. S.; Gloyna, Earnest F. (Texas Univ., Austin). May 13, 1968. Contract AT(11-1)-490. 41p. (CONF-680516-1). Dep. CFSTI.

From ASCE Environmental Conference, Chattanooga, Tenn.

A transport relationship which considers the sorption–desorption characteristics of a non-biodegradable solute was developed. The radionuclide, ^{85}Sr, was used to test the transport hypothesis under a variety of environmental conditions. Experiments included evaluation of the sorption of ^{85}Sr by sediments in both flowing and non-flowing aquatic systems. (auth)

37877 (UCRL-18140, pp 145-58) DISTRIBUTION OF ^{210}Pb AND ^{226}Ra IN SOIL. Fisenne, Isabel M. (Atomic Energy Commission, New York).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

The ^{226}Ra and ^{210}Pb content of typical tobacco-growing soil was studied as a function of depth. The depth profile samples, including surface vegetation, were collected at an undisturbed area in Maryland. It was of interest to determine whether these nuclides concentrate in the upper horizons of this soil type. ^{210}Pb generally decreased with increasing depth, resulting in a decrease in the $^{210}Pb/^{226}Ra$ ratio. An attempt was made to correlate this trend with the known radon emanation rates from soil. (auth)

37878 ORIGIN OF RADIOACTIVITY AT NIUE ISLAND. Schofield, J. C. (New Zealand Geological Survey, Papatoetoe). N. Z. J. Geol. Geophys., 10: 1362-71(Dec. 1967).

Origin of the high soil radioactivity on Niue, an isolated island in the South Pacific, is discussed. The high radioactivity of the Niuean soils is similar to that found in deep sea sediments. Ionium and ^{226}Ra are the source of the bulk of the radioactivity on Niue. Because of the greater solubility of U, separation from the daughter products occurs in seawater, the high radioactive content in deep sea sediments being due to a slow rate of clastic deposition compared with the deposition of shelf sediments. The rate of sedimentation in deep sea areas is unlikely to have been as rapid as in the now dry lagoon at Niue; hence, a seawater origin for the abnormally high radioactivity at Niue is unlikely. A separation from U of the daughter products also takes place in hydrothermal solutions which could have come from the volcanic substructure at Niue, possibly phonolite, one of the most radioactive igneous rocks. The anomalous distribution of radioactive soil values at Niue favors a volcanic origin rather than a seawater origin. Evidence is also presented that radioactivity in the limestone was derived from ground water and not percolating rainwater. Ground water is the main source of freshwater at Niue and if hydrothermal activity is still present, the ground water may be injurious to health and should be tested for radioactivity. (BBB)

Meteorology

37879 (BNWL-441) LOW-LEVEL ISENTROPIC TRAJECTORIES AND THE MIDAS COMPUTER PROGRAM FOR THE MONTGOMERY STREAM FUNCTION. Engelmann, R. J.; Davis, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

The optimum trajectory for releases of materials at low elevations in the atmosphere is constructed with isentropic charts. Isentropic analysis reveals vertical motions of the material and predicts where the material will appear in the air near the ground. An example of such a trajectory that provides a thorough error analysis of isentropic data, and gives the details of a digital analog simulation computer program for obtaining isentropic data is presented. (auth)

37880 (BNWL-SA-1639) FISSION, FUSION, AND AUTOMOBILES. Unruh, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 31, 1968. Contract AT(45-1)-1830. 7p. (CONF-680607-4). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

Many have advanced the concept that nuclear power plants minimized atmospheric pollution by avoiding fossil fuel combustion products. Within the next century power generation from fusion reactors may become a reality and the generation of fission product liability may be avoided. Some recent studies have indicated that ^{3}H generation from fusion reactors may become a serious atmospheric pollution problem from future power plants. It is difficult to strike a meaningful balance between the acceptability of a given worldwide radiation dose and the power to be gained from the power plants. It is particularly difficult to assign a balance factor to the multi-century storage required for the vast inventory of fission products generated by fission reactors. Insight into this balance may be attained by comparing the significance of the worldwide radiation doses with more commonly encountered pollutants such as lead in the atmosphere. The rapid increase in automobile traffic throughout the world is resulting in rapidly increasing atmospheric lead contents. By the year 2000 some one billion pounds of lead per year will be placed in the atmosphere from automobile exhausts. A balance of risk and acceptability is needed to assure that fusion reactors and their waste ^{3}H receive analysis in the proper frame of reference with respect to other human insults, such as lead. (auth)

37881 INVESTIGATION OF THE ^{85}Kr ACTIVITY OF THE ATMOSPHERE. Csongor, Eva. ATOMKI (At. Kut. Intez.) Kozlem., 10: 1-7(Apr. 1968). (In Hungarian).

The ^{85}Kr content of the atmosphere was investigated by GM counters filled with Kr and isobutane. The activity of the atmosphere due to ^{85}Kr was 11.5×10^{-12} Ci/m^3 air in Dec. 1966. The total ^{85}Kr activity of the atmosphere amounts to 47.2 MCi which is equivalent to about 120 tons of thermal fissioned ^{235}U. It is shown that the ^{85}Kr is mainly ascribed to atomic industrial origin. (auth)

37882 VERTICAL DISTRIBUTION OF THE NATURAL RADIOACTIVITY IN THE FREE ATMOSPHERE AT THE MEAN CLOUD LEVEL. Styro, B. I.; Chkhenkeli, Sh. M.; Tavartkiladze, K. A.; Khundzhua, T. G. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 49: 65-8(Jan. 1968). (In Russian).

The regularity of natural radioactivity distribution in the free atmosphere in the presence of low level clouds and low velocity wind was determined on the basis of experimental data. The data obtained on the vertical profile of natural radioactivity were further used for evaluating turbulent diffusion. The data on radon concentration in the upper atmosphere were gathered during 10 flights in the second half of 1966 and measured from 500 m to a height of 5.5 to 6 km. Graphs are included on the vertical turbulent diffusion as a function of elevation and temperature. (R.V.J.)

37883 CHRONOLOGICAL CHANGES OF NATURAL RADIOISOTOPES, THE DECAY PRODUCTS OF RADON IN THE

TROPOSPHERIC LAYER NEAR THE EARTH. Kopcewicz, Teodor (Univ., Warsaw). Przegl. Geofiz., 13: 43-74(1968). (In Polish).

Natural radioisotopes, the decay products of radon and thoron, are characterized generally and their vertical distribution in the atmosphere was investigated. Continuous measurements of the β activity of these natural radioisotopes were made and daily and yearly variations were observed. (M.C.G.)

37884 GENERALITIES ON AEROSOLS AND MISTS. DEFINITIONS AND PHYSICAL STRUCTURE. Guillot, Marcel (Faculte de Pharmacie, Paris). Prod. Pharm., 20: 5-13(Jan. 1965). (In French).

One of the methods for determining aerosol structure involves generation of a radioactive disperse element and detection by simple photography; lengths of trajectories, easily measured microscopically, permit the determination of the energy of the particle and thus serve as a tool for qualitative analysis of the element, particularly for α radiation. For isolated atoms, a single track is found; for clustered atoms, a star of tracks, so that aggregation can be determined. A detailed procedure for studying dispersions of ThB, ThC, and ThC′ (from thoron) is presented as a method for studying the efficiency of filters; one can study both the number of particles making tracks, and also the nature of the tracks. This is a simple comparative method for studying very different types of filters. The nature of radioactive fallout is discussed. (BBB)

37885 RADIOCARBON FROM NUCLEAR WEAPONS TESTS AND ITS USE AS A GEOPHYSICAL TRACER. Young, James Allan. Seattle, Univ. of Washington, 1967. 114p. Thesis.

The 1961 to 1962 nuclear weapons tests injected 4 MCi of ^{14}C into the atmosphere, mostly in the northern hemisphere high latitude stratosphere. It seemed likely that this ^{14}C would prove to be a valuable tracer for the study of global atmospheric circulation patterns, and also for the study of the rate of exchange and mixing of atmospheric CO_2 with the CO_2 of the sea. Starting in 1963, atmospheric CO_2 samples were collected for ^{14}C analysis at ground level and near the tropopause in the Puget Sound region. Ground level atmospheric CO_2 samples were also collected at Barrow, Alaska, and on Arlis II, an ice island floating near the north pole. Sea water CO_2 samples were also collected at several latitudes in the northern hemisphere. The flux of excess ^{14}C from the troposphere into the sea was calculated as a function of location and time by assuming that the rate of exchange of CO_2 between the atmosphere and the sea was proportional to the square of the wind speed, as has been demonstrated by Kanwisher. The rate of exchange was calculated to be twice as great for the southern hemisphere as for the northern hemisphere. The residence time for a CO_2 molecule in the troposphere was determined to be 1.9 yr for the southern hemisphere and 3.9 yr for the northern hemisphere, giving an average of 2.5 yr for the world. Since the residence time for a CO_2 molecule in the stratosphere was calculated to be 1.6 yr, using stratospheric ^{14}C concentrations reported by HASL, the residence time in the atmosphere before entering the sea is about 4 yr. Two vertical ^{14}C profiles were measured 16 mo apart in the Pacific Ocean at about 48°N and 132°W. The measured activities showed that the amount of ^{14}C added to the sea during the 16 mo was very nearly equal to the amount calculated using wind speed data, which adds confidence to the above calculations. An eddy diffusion model was developed which was fairly successful in interpreting the distribution in time and space of excess ^{14}C in the northern hemisphere troposphere from 1963 through 1965. Using this model, it was calculated that about 79% of the excess ^{14}C injected into the northern hemisphere troposphere was injected from 30° to 50°N. Meridional eddy diffusion coefficients of 10^{10} to 10^{11} cm^2 sec^{-1} were needed to account for the rate of diffusion of this ^{14}C to other latitudes. The eddy diffusion coefficient was highest at midlatitudes. A more complete description of the ^{14}C distribution would probably have to include the effects of mean meridional motions, especially at low latitudes where eddy diffusion is smallest. (Disser. Abstr.)

37886 DETERMINATION OF THE WASHOUT COEFFICIENT OF ARTIFICIAL RADIOACTIVE PARTICLES. Meszaros, E.; Simon, A. Idojaras, No. 3, 158-63(1967). (In Hungarian).

A simple model, in which integrations are made with amounts of precipitation rather than duration of rain, is used to determine the washout coefficient of radioactive particles and the effect of various factors on the concentration of radioactive particles in rainwater. Calculations showed that the washout coefficient is on the order of 10^{-2} and that the concentration of radioactive particles in rainfall is 10 to 20% of the total amount. (JPRS)

37887 FALLOUT OF ARTIFICIAL RADIOACTIVE PARTICLES FROM THE TROPOSPHERE IN DRY AND WET WEATHER. Meszaros, Erno; Simon, Antal. Idojaras, No. 2, 96- (1967). (In Hungarian).

Research data indicate that the mean rate of settling of artificially produced radioactive particles from the troposphere on rainless days is 0.17 km/day. On rainy days the fallout rate increases to 3.14 km/day. The possibility for individual types of fallout (washout) is a function of the amount of precipitation. Apparently, eddy diffusion in the atmosphere controls the amount of dry fallout, while intra-cloud processes control the amount of wet fallout. (JPRS)

37888 UNITED STATES TRITIUM RAINOUT AND ITS HYDROLOGIC IMPLICATIONS. Stewart, G. L.; Farnsworth, R. K. (Geological Survey, Washington, D. C.). Water Resour. Res., 4: 273-89(Apr. 1968).

Tritium contents of precipitation, total rainout, and rainfall amounts for 1964 and 1965 are listed for 15 stations in the conterminous United States, Alaska, and Puerto Rico. The major increase in tritium rainout observed in 1963 was followed by a decline of about 27% in 1964 compared with 1963, and an additional decline of about 54% in 1965 compared with 1964. Rainout patterns are characterized by increases in tritium rainout with northern latitudes and with distance from the oceans. The total tritium rainout, being a function of both concentration and amount of precipitation, is more random than average tritium concentration. Seasonal, annual, and even 10-yr tritium pulses provided a valuable tag for tracing water in many kinds of hydrological and meteorological investigations. The tritium data now available make it possible to estimate the tritium input to the hydrologic environment in any part of the United States. (BBB)

37889 VERTICAL DISTRIBUTION OF ARTIFICIAL RADIOACTIVITY IN THE BOTTOM 300-METER LAYER OF THE ATMOSPHERE. Meszaros, E.; Simon, A. Idojaras, No. 3, 173-4(1967). (In Hungarian).

Results of observations carried out at the Budapest Aerological Observatory and at the Central Scientific Research Institute for Physics indicate that in the lowest 300 meters of the atmosphere, the vertical gradient of artificial beta-radioactivity may be equal to zero. (JPRS)

37890 PROGRAM FOR COMPUTING EXTERNAL DOSE RATE FROM A RADIOACTIVE CLOUD AND NUMERICAL EXAMPLES FOR NUCLEAR SHIPS. Sato, Ken'ichiro; Ito, Yasuyoshi. Senpaku Gijutsu Kenkyujo, 5: No, 2, 55-63(Mar. 1968). (In Japanese).

A program for calculating the external dose rate from a radioactive cloud was written in 06 NARC language (analogous to FORTRAN). The basic equation used for the atmospheric dispersion is equivalent to the so-called generalized Gaussian plume formula with the stack and the inversion lid modifications. The numerical integration was performed using the Legendre-Gauss quadrature technique together with the polar coordinate system developed by D. S. Duncan. The time required for the integration was found around forty minutes on the NEAC-2206 computer. The typical results from the program are shown in graphical form putting emphasis on the safety of the persons in the vicinity of a nuclear ship. To help the discussion, the results from the usual method of evaluation based on the assumption of infinitely spread cloud are also presented. Thus, the great safety factors involved in the conventional analysis are easily estimated as functions of downwind distance. For example, the actual finite cloud dose for the meteorological category F is lower than that computed for the infinite cloud by a factor of approximately 70 at 100 m downwind distance, and by a factor of approximately 2 even as far from the stack as 10 km. Another important result of the calculation is the remarkable discrepancy between the isodose and the isoconcentration lines at distances close to the stack. It must be remembered, however, that the basic equation for the region extremely close to the stack is not yet well established, so the analysis for the region was made by extrapolating the available data. For this reason, the results may be considered as a measure for estimating the safety factors involved in the conventional analysis. (NSA of Japan)

Mineralogy and Exploration

Refer also to abstract 39656.

37891 ELEMENTS OF INTEREST FOR NUCLEAR TECHNOLOGY IN THE SANDS OF NETTUNO, ROME. Orvini, E.; Rollier, M. A.; Soldi, T. F. (Univ., Pavia). Chim. Ind. (Milan), 50: 215-20(Feb. 1968). (In Italian).

Minerals in the sands from Nettuno beach near Rome include perrierite, thorite, monazite, magnetite, ilmenite, and zircon. A sample of the nonmagnetic, high-density fraction (rare earths concentrate) of the sands was analyzed by conventional chemi-

cal and neutron activation analysis. The rare earths concentrate accounts for 0.18% of the sand; 20,000 tons of the concentrate would contain: ThO_2 6.48 t, SnO_2 10.4 t, U_3O_8 1.34 t, and ZrO_2 12.2 (on the basis of the analyzed fraction only). Thorium-bearing sands of similar content, such as those at Kerala, India, are considered also as a convenient source for the recovery of this element. However, the Kerala monazite sands have a U_3O_8/ThO_2 ratio of 1/20 to 1/30 compared to 1/4.8 for the Nettuno beach sands. The Nettuno sands contain only very small amounts of Hf, the HfO_2/ZrO_2 ratio being 1/470. Possibilities of recovery of these elements from the sands are discussed. (BBB)

37892 RENEWED URANIUM EXPLORATION. Mining J. (London), 270: 237 (Mar. 29, 1968).

A new search for domestic sources of U is to be made in Britain, by the Institute of Geological Sciences, on behalf of the UKAEA. The £250,000 reconnaissance prospecting program has the object of establishing whether there is enough U present to justify a more detailed search. Important advances have been made in prospecting techniques, notably in aerial surveying. These include a γ-ray spectrometer which can detect the presence of U or Th from 500 ft. However, the search is to be made primarily on the ground. Britain is developing a further insurance against any possible future shortage of U through research into the extraction of U from the sea. Engineering studies indicate a cost of £25,000 to £40,000 per metric ton. This would be equivalent to a price of $20/lb of uranium oxide, which is more than the estimates of $12 to $15/lb of oxide from Swedish sources, but considerably more attractive than the granite ores ($50 to $100) which the U.S.A. is beginning to examine. Assuming that the price of UO_2 rises to $10/lb, a figure widely mentioned, and that the cost of the process can be further reduced, extraction of U from seawater might eventually become economic. Seawater contains 3.34 millionths of a g/l of U. The Harwell method of extraction is based on hydroxide granules which selectively absorb U. Recovery is effected by leaching at intervals with a solution of ammonium carbonate. The method tested on a lab scale in beds a foot in dia is now to be scaled up to a bed about 6 ft^2 that will extract about 10 g of U in the course of an 8-day cycle. (BBB)

Oceanography

37893 (SC-CR-68-3532) DEVELOPMENT OF OCEAN DIFFUSION MODELS. Mikhail, S. Z.; James, L. R. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 1968. Contract ASB48-6183. 23p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The assumptions, approximations and basic equations used in developing, evaluating and programming two ocean diffusion models are described. The first model assumes an instantaneous point source release while the second considers a slowly dissolving radioactive source. Preliminary results for the instantaneous case are presented and future plans for continuing the development and evaluation of these two models are detailed. (auth)

Seismology

Refer also to abstract 39963.

37894 (N-68-12023) SEISMIC DETECTION OF NEAR-SURFACE CAVITIES. Its Professional Paper 599-A. Watkins, Joel S.; Godson, Richard H.; Watson, Kenneth (Geological Survey, Washington, D. C.). 1967. 17p. (NASA-CR-91049). CFSTI.

Oscillations with durations of 1 second or more with narrow frequency bands have been observed over cavities in lava and alluvium at depths ranging from 1 to 14 meters. They are probably primarily radial oscillations of cavity walls, and calculations show that dominant frequencies are generally within a factor of 3 of those computed from M. A. Biot's theoretical results for radial oscillations of a cylindrical hole in an infinite solid. Delays in arrival times and anomalous attenuation of seismic waves traversing cavities have also been observed. Fractures and broken rock in the chimney above a nuclear explosion cavity is thought to be responsible for delays in Rayleigh waves and delays in what are probably trapped waves. Fourier analysis and autocorrelation have been used successfully to detect these and similar resonant phenomena in noisy backgrounds; crosscorrelation of proximate traces was less successful for this purpose. (auth) (STAR)

37895 P TIMES FROM THE NUCLEAR EXPLOSION GREELEY. Cleary, John (Australian National Univ., Canberra); Hales, Anton L. Earth Planet. Sci. Lett., 4: 305-9(June 1968).

P times from the nuclear explosion Greeley are in substantial agreement with the Cleary–Hales travel time curve. The Greeley data suggest that there is a small azimuthal variation in the source term at the Nevada Test Site. The direction found for the maximum value of this source term is close to those observed at other stations in California and Nevada. (auth)

37896 REMARKS ON THE PAPER "A SURVEY OF COMPLAINTS OF SEISMIC RELATED DAMAGE TO SURFACE STRUCTURES FOLLOWING THE SALMON UNDERGROUND NUCLEAR DETONATION," BY DEAN V. POWER. Hammon, Stratton; Hammon, Neal (Vibration Damage Specialists, Louisville, Ky.). Bull. Seismol. Soc. Amer., 58: 1169-72(June 1968).

General remarks on a previous paper on seismic related damage to surface structures following the Salmon underground nuclear detonation are presented. The social and scientific implications of damage claims which result from underground nuclear explosions are briefly reviewed. Very few claims are received in poor areas. The majority of complaints are received from low to middle income neighborhoods. Owners of large dwellings and business concerns rarely make claims for vibration damage. (R.C.K.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 37657 and 37896.

37897 (NVO–1163-49(Rev.1)) A SUMMARY OF GROUND MOTION PREDICTION PROCEDURES AND EQUATIONS. Davis, Lawrence L. (Beers (Roland F.), Inc., Alexandria, Va.). Mar. 23, 1965. Contract AT(29-2)-1163. 50p. Dep. CFSTI.

In spite of the great number of instrumented underground events, large gaps exist in the empirical data. Even where data are available, the limitations in the frequency response of the instruments may have permitted a portion of the seismic energy to go undetected. Predictions can be made, with good empirical support, for events in Yucca Flat if the yields are less than Bilby and the event location is east of Yucca Fault. Tuff predictions have been reasonably well checked by data from a wide range of yields. For granite, the Shoal effects were predicted very well, but no check on yield scaling for events in granite is available. Detailed analysis of the Salmon data and comparison with the Gnome data may provide a better basis of predicting events in salt. However, the small range of yields is a serious drawback to the determination of empirical equations for general use. For other media, much more data are required before reliable empirical equations can be derived. (auth)

37898 (PNE–5012-I) ENGINEERING PROPERTIES OF CRATERS. DESCRIPTION OF CRATER ZONES AND SITE INVESTIGATION METHODS. Report I. Fisher, Paul R. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Feb. 20, 1968. 78p. Dep. CFSTI.

The current state of knowledge concerning the physical character of the distinct zones of disturbance surrounding a nuclear or high explosive crater, the scope and techniques of engineering properties investigations at the sites of cratering experiments, and methods for predicting the character of crater zones from the results of predetonation investigations are discussed. Information is based on data obtained from craters produced in dry materials. The distinct zones of disturbance observed at nuclear and high explosive craters are the fallback zone, the ejecta zone, and the rupture zone (which includes the zone of upthrust). Characteristics for craters in dry materials may be predicted with reasonable accuracy. (J.C.W.)

37899 (VUF–1029) PRE- AND POSTSHOT STRUCTURAL SURVEY: PROJECT DRIBBLE, SALMON EVENT. Final Report. Harvey, D. M.; Jackson, M. W.; Linville, F. A. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). Nov. 1966. 97p. Dep. CFSTI.

Project Dribble, Salmon Event, consisted of Pre-shot and Postshot surveys. The Pre-shot Survey was subdivided into three phases. The Phase 1 report issued in preliminary form contained data on the nature and condition of structures located on 67 parcels of land off the Dribble Site and out to 4.2 km (2.6 miles) from surface zero, (SZ). At this range the ground motion was predicted to be approximately 9 cm/sec peak particle velocity. The Phase 2 report contained similar data on the condition of structures located on 215 parcels of land beyond 4.2 km (2.6 miles), but within 7.2 km (4.5 miles) of SZ. The predicted peak ground motion at this range was 4.5 cm/sec peak particle velocity. Phase 2 report also included a survey on the condition of 11 important bridges within 4.2 km (2.6 miles) of SZ. Phase 3 survey was conducted just prior to the event to investigate changes to previously surveyed structures and to include new structures, structures on the Dribble Site, and selected structures between 7.2 km (4.5 miles) and 16.1 km (10 miles) of SZ. The phase 3 report was issued to update the previous reports and to document the structural bracing which had been installed to minimize the potential damage. After the event all structures were re-examined, and the postshot conditions were described in Postshot Structural Survey. All pre-shot and postshot structural survey reports are summarized, and final conclusions and recommendations presented. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 37775, 38615, 39000, 39006, 39007, and 39201.

37900 (BNL–50082, pp 153–80) ENGINEERING DIVISION. Sheehan, T. V. (Brookhaven National Lab., Upton, N. Y.).

Research on liquid metal heat transfer concerned primarily with potassium, sodium, and mercury is reported. Developments on processes to convert radioactive waste solutions to stable solids are described. Safety studies devoted primarily to Na-cooled fast reactors are described. Included in the studies are investigations of fission product transfer, aerosol behavior mechanics, and chemistry of I_2 released to steam. Other work is reported on distillation of seawater, and pulsed research reactor development. (J.R.D.)

37901 (BNWL–613) EXPLORATION OF THE PROBLEMS ASSOCIATED WITH THE NEUTRON IRRADIATION OF SAMPLES UNDER HIGH HYDROSTATIC PRESSURES. Kulcinski, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 95p. Dep. CFSTI.

Problems associated with the design of equipment to generate high hydrostatic pressures on samples which are simultaneously irradiated to a neutron fluence of 10^{18} nvt are discussed. Basically, the capsule incorporates a clamping type method of maintaining pressure in conjunction with the tapered cylinder pressure support concept. Pressure stability and calibration is obtained by the use of an alkali halide, immersed with the sample in a liquid metal pressure transmitting media. The liquid metal is contained by use of a Bridgman seal arrangement. The overall dimension of such a cell could be approximately 2.75 in. in dia approximately 6 in. long, if it is constructed out of high strength, low alloy steel. This cell could accommodate a sample of slightly less than 0.25 in. in dia and 0.5 in. long which can be subjected to approximately 20 kbars of pressure while it is inside a nuclear reactor. (J.C.W.)

37902 (CONF-680802–2) MAGNETIC FORCE UNBALANCE AND FLUX DISTRIBUTION IN INDUCTOR ALTERNATORS. Kouba, C. C. (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Aug. 1968. Contract AT(04-3)-679. 33p. Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

The radial magnetic unbalance force acting on the rotor of a 467 kVA inductor alternator and the flux distribution within the alternator magnetic circuits under static (non-rotating) conditions are determined. The maximum rotor force was found to be a linear function of rotor eccentricity with a slope of 19,000 psi of rotor eccentricity. A new procedure for calculating the ac flux in the armature core was formulated. (auth)

37903 (CONF-680802–3) INDUCTOR ALTERNATOR ROTOR FOR SPACE APPLICATION. McCabria, Jack L. (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Aug. 1968. Contract AT(04-3)-679. 19p. Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

The technology and design criteria for the rotor in a radial gap, potassium cooled, inductor alternator are discussed. Specific attention is given to the rotor material limitations, most favorable rotor speeds, and the reduction of pole face and windage power losses. Unique design considerations for the rotor cooling scheme are presented for alternator ratings between 0.4 and 12 MVA. (auth)

37904 (DUN-SA–66) RELIABILITY ANALYSIS OF NUCLEAR REACTOR ELECTRONIC SYSTEMS. Rohrbacher, R. A. (Douglas United Nuclear, Inc., Richland, Wash.). June 17, 1968. Contract AT(45-1)-1857. 38p. (CONF-680803–2). Dep. CFSTI.

From Western Electronic Show and Convention Conference, Los Angeles, Calif.

Reliability estimates and predictions of electronic systems in nuclear reactors are considered in reactor design. The reliability of a component device, or system is the successful performance for a specified period of time under certain conditions. Reliability evaluation, theory, failure sequence analysis, and effect analysis are discussed. Reliability models are presented and a fault tree analysis used at Hanford is given. (J.C.W.)

37905 (HZ–1/67) ERSTE BETRIEBSERFAHRUNGEN IM BRENNSTOFFZELLENLABOR DER KERNFORSCHUNGSANLAGE JUELICH. (First Operating Experience in the Fuel Cell Laboratory of the Juelich Nuclear Research Center). Herren, M.; Mueller, H.; Stockschlaeder, F. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Aug. 1967. 38p. (In German). Dep.

The experiences with start-up operation and initial operating time of two hot laboratories in the Juelich Nuclear Research Center are reported. The operational possibilities in the cells

were described and the equipment, which essentially is for two large irradiation programs (the rod fuel elements which are to be irradiated in the FRJ-2 in two loops and the graphite sphere fuel elements and coated particles which originate from irradiation experiments in the THTR project), is discussed in detail. The difficulties which arose during the start-up of the cells were indicated. The methods used in the re-equipping of the boxes and in the replacement and repair of manipulators were reported. Experience in the decontamination and radiation monitoring was also discussed. (tr-auth)

37906 (ORNL-4288) ATTENUATION OF SHOCK WAVES IN LONG PIPES BY ORIFICE PLATES, ROUGH WALLS, AND CYLINDRICAL OBSTACLES. Dresner, Lawrence; Chester, Conrad V. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Exploratory measurements of the attenuation of shock waves in tubes by orifice plates, rough walls, and cylindrical obstacles are reported. The measurements were carried out in a four-inch shock tube driven by an explosive mixture of propane and oxygen. It appears possible to correlate the attenuation produced by obstacles placed in the flow with their Fanning friction factors. The orifice plates and cylindrical obstacles are very efficient attenuators. (auth)

37907 (N-68-19146) NUCLEAR THERMIONIC SPACE POWER SYSTEM CONCEPT EMPLOYING HEAT PIPES. Heath, Colin A.; Lantz, Edward (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 24p. (NASA-TN-D-4299). CFSTI.

A space power system employing out-of-pile thermionic diodes and using concentric heat pipes for both heating and cooling of these diodes has been examined. For an early application, the out-of-pile thermionic diode has some advantages over an in-pile system because it is removed from the reactor environment. Moreover, the heat pipe permits emitter temperatures that are not much less than the temperature of the fuel clad. Laboratory data on the performance of heat pipes have been examined and the results used to estimate reasonable performance levels for thermionic diodes which were consequently incorporated into a small, fast-spectrum nuclear reactor concept. Performance levels and system weights including shield weights, have been estimated from first order calculations. The overall system can have the advantage of the safety inherent in heat pipe redundancy and the improved performance available from components that are removed from the reactor environment. (auth) (STAR)

37908 (N-68-21499) COMPUTER PROGRAMS FOR PLANE COLLISIONLESS SHEATHS BETWEEN FIELD-MODIFIED EMITTER AND THERMALLY IONIZED PLASMA EXEMPLIFIED BY CESIUM. Button, Susan L.; Morris, James F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 70p. (NASA-TM-X-1562). CFSTI.

Two computer programs coded in FORTRAN IV are described for plane collisionless positive-ion and electron emission sheaths. Given the emitter temperature, emitter work function, atomic ionization potential, plasma electron and ion number density, and plasma electron, ion, and atom temperatures, the programs compute current densities, potential drop through the sheath, charge density, electron field, and sheath distance. (auth) (STAR)

37909 (ORNL-TM-2071) DEVELOPMENT OF IODINE CHARACTERIZATION SAMPLER FOR APPLICATION IN HUMID ENVIRONMENTS. Bennett, R. L.; Hinds, W. H.; Adams, R. E. (Oak Ridge National Lab., Tenn.). May 1, 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

The high fission yield in nuclear reactors, its preferential release from over-heated fuel, and its significant biological hazard combine to make radioiodine one of the more important isotopes in the field of nuclear safety. To be able to assess the hazard of an accidental release of the iodine from a reactor, and to predict its subsequent behavior, one must have knowledge of the chemical and physical forms of the radioiodine. Iodine vapor may exist in the elemental form or be converted to volatile organic compounds by reaction with trace organic impurities on surfaces and in air. Radioiodine may also acquire the characteristics of a solid aerosol by adsorption onto the surfaces of fine particulate matter. Research, at various scale levels, is being conducted at several locations to study the behavior of iodine as it relates to nuclear safety. Analytical samplers are needed which are capable of distinguishing and measuring particulate, elemental and the less reactive iodine forms, such as methyl iodide, in these experimental studies. A major problem in the application of the May pack iodine sampler has been the difficulty in defining the proper sequence of materials that will reproducibly separate the particulate iodine from elemental iodine. When high-efficiency filters were used in the inlet section to remove particles and particulate iodine, significant quantities of elemental iodine were also retained. The reverse arrangement in which silver screens (for retention of elemental iodine) were placed before the high-efficiency filters allowed a significant trapping of particles, along with the desired removal of elemental iodine. An improved iodine sampler has been devised. This device contains a silver-plated aluminum honeycomb inlet section as the particulate iodine-elemental iodine separator. As the iodine passes through the channels of the honeycomb it is removed as a consequence of its greater diffusivity, while the larger aerosol particles, with much smaller diffusion coefficients, pass through to the high-efficiency filter section. Less-reactive iodides, such as methyl iodide, pass through both sections and are adsorbed in an impregnated charcoal bed. Test data to support this iodine sampling concept are presented. (auth)

37910 (RL-REA-2228) TAMPER: INDICATING SAFING SYSTEM. Fullmer, G. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 12, 1965. Contract AT(45-1)-1350. 42p. Dep. CFSTI.

The design of a safing wire and a safing seal is described. The manner in which they and supporting equipment may be prepared and utilized for detection of tampering is described. (J.C.W.)

37911 (TID-24495) DEAERATORS FOR DESALINATION PLANTS. Research and Development Progress Report No. 314. (Oak Ridge National Lab., Tenn.). Dec. 1967. 117p. GPO $0.60.

For Office of Saline Water, Washington, D. C.

The deaerator study includes an outline of the state-of-the-art information on existing deaerators, research and test work performed by Office of Saline Water contractors, and the availability of commercial deaerators. On the basis of the study, it is recommended that a test program be undertaken to evaluate the performance of the most promising deaeration methods. (P.C.H.)

37912 SAFETY DEVICE FOR TONGS IN THE WATER. Goto, Jiro (to Hitachi Ltd.). Japanese Patent 1967-17920. Oct. 17, 1967. Filed Oct. 23, 1963.

The device proposed is for protecting tongs when they move in the water of a spent-fuel storage tank. The rod of tongs goes into the (pool) water, supported at the bridge. A wire runs along this rod into the water, the lower end being held with some distance from the rod. The upper end of this rope is wound around a drum on the bridge, through a pulley. The pulley is set on one end of a lever, situated horizontally above the drum, with the lever being rotatable slightly like the balance bar. At the other end of this bar is attached an electrical contact, forming an outside electric circuit with another contact. When an object hits the wire in the water, the pulley, and hence, the (corresponding) end of the lever is pulled down, thereby joining the two contacts. The circuit is thus connected, putting on a warning light. (NSA of Japan)

37913 IMAGE-DETECTING PLATE FOR NEUTRON RADIOGRAPHY. Ogawa, Yukio (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-14637. Aug. 21, 1967. Filed Aug. 31, 1963.

By the method proposed, the strength of an image-detecting plate and the images can be improved. The foil of indium or gadolinium, for detection of the thermal neutrons, is supported by attaching to it a plate (or plates) of a material (or materials), which is hardly activated by the irradiation, scatters the neutrons to a negligible extent and has a high mechanical strength. Such materials suitably employed for the purpose are Al, Mg, Ti, Zr, Cr, Fe, Sn and Pb. (NSA of Japan)

37914 DEVICE OF NEUTRON RADIOGRAPHY. Ogawa, Kazuyuki (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-16479. Sept. 5, 1967. Filed June 30, 1964.

The neutron-radiography device proposed employs a particle accelerator (connected to the neutron-producing target), in place of a nuclear reactor; and, yet, its sensitivity is fairly high. In addition, the construction is simple and economical, and the maintenance is easy. It consists of the following: a particle accelerator for producing neutrons; a moderator surrounding the (neutron-producing) target place; a shield covering the moderator with a neutron-beam hole; a means for supporting a subject against the beam hole; and, a high-sensitivity image detector (located behind the subject) consisting of a scintillator to detect the penetrating neutrons; and an image-taking device. (NSA of Japan)

37915 REMOTELY OPERATED PIPETTER. Emura, Satoru; Nakahara, Yoshinori; Onuki, Mamoru; Kono, Nobuski (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 9: 705-9(Dec. 1967). (In Japanese).

Two positive delivery pipettes (1 ml and 5 ml in capacity) have been devised for pipetting aliquots of highly radioactive liquid

samples used in various analytical determinations in the reprocessing analytical facility. The pipette assembly consists of pipet, electrical elevator, control unit, three valves and trap, as well as nitrogen gas and vacuum lines. The structural material of the parts of the pipet in contact with the sample are either stainless steel or teflon. A precision of 0.2% standard deviation of successive 100 μl deliveries of distilled water and concentrated nitric acid was obtained on the 1 ml pipette. Design criteria for the pipette, its principle of operation, and method of decontamination are described. (auth)

37916 COUNTERBALANCED MANIPULATOR. Flatau, C. R. (to United States Atomic Energy Commission). U. S. Patent 3,391,804. July 9, 1968.

A counterbalanced manipulator utilizing negator springs for supplying a uniform force and analog devices for producing moment arms to counteract the unbalancing effects due to gravity is described. The unbalancing effects are neutralized to the exact degree continuously over the whole range of manipulator operation. (AEC)

37917 SEMICONDUCTING SHUNTS FOR STABILIZING SUPERCONDUCTING MAGNET COILS. Hintz, Ronald E. (to United States Atomic Energy Commission). U. S. Patent 3,393,386. July 16, 1968.

An improved superconducting coil in which semiconducting shunts contact each turn in the coil, the shunts providing alternate current paths when one or more turns go to normal conduction is described. The shunts are a series of oxidized copper wafers which act as insulations at superconducting temperatures, but readily conduct at higher temperatures. (AEC)

37918 NUCLEAR REACTOR FUEL ELEMENT. Ross, Wilfred T.; Venier, Dominic A. (to General Electric Co.). U. S. Patent 3,378,458. Apr. 16, 1968. Filed Oct. 19, 1965.

A fuel assembly incorporating fuel elements of open ended tubular channels and fuel element spacer devices is described. A plenum spring in the plenum chamber where fission product gases are collected, is provided and the design is directed toward the association between the top end plug, upper end of tube, and the end loop of the plenum spring. (J.C.W.)

37919 FURNACE FOR MANUFACTURING INGOTS OR BARS OF METAL OR ALLOYS, PARTICULARLY BARS OF URANIUM CARBIDE. Accary, Andre; Treillou, Andre; Trouve, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,388,903. June 18, 1968. Priority date Dec. 9, 1963, France.

The design of electron beam furnaces for manufacturing ingots or bars of metal, particularly bars of uranium carbide, is given. An electron beam furnace of the instant type generally comprises an enclosure having vacuum pumping means attached thereto. Within this enclosure is a bottomless double walled crucible of a cylindrical shape which diverges at the upper end to receive and contain metal. A head, vertically movable within the cylinder, and means for controlling the movement thereof constitute the base of the furnace. One or more electron beams are directed into the upper open end of the casting crucible to heat metal therein. The furnace also includes means for circulating a coolant fluid in the double wall of the crucible and a system for supplying the material to be melted, in granular form. (auth)

37920 RULES FOR CONSTRUCTION OF NUCLEAR VESSELS, 1968 EDITION. ASME Boiler and Pressure Vessel Code, Section III. New York, American Society of Mechanical Engineers, 1968. 252p. $12.00.

Requirements for the materials, design, fabrication, inspection and testing, and certification of vessels for use in the nuclear energy system of any power plant are presented. A nuclear energy system is that part of a power plant that serves the purpose of producing and controlling an output of thermal energy from nuclear fuel. Vessels for which rules are specified are those which are designed to provide a pressure retaining barrier in a nuclear energy system or for the overall containment of the system. Included are vessels which are designed to contain the reactor coolant or moderator, or separate the reactor coolant or moderator from any heat transfer media required in the performance of system functions. Vessels for the collection and disposal of nuclear waste from the system are included if they are subject to pressures greater than would prevail if they were vented to atmosphere. The rules provide requirements for new construction and for mechanical and thermal stresses due to cyclic operation. They do not cover deterioration which may occur in service as a result of radiation effects, instability of the material, or the effects of mechanical shock or vibratory loading. These effects shall be taken into account with a view to obtaining the design or the specified life of the vessel. It is recommended that the increase in the brittle fracture transition temperature due to neutron irradiation be checked periodically by means of surveillance specimens of the same material which receive approximately the same neutron flux as the vessel wall at about the same temperature and neutron energy spectrum. The combined effects of fabrication, stress, and integrated neutron flux should be considered. (auth)

37921 PALLET BOX IRRADIATOR. (to Atomic Energy of Canada, Commercial Products). British Patent 1,113,765. May 15, 1968. Priority date Feb. 1, 1965, Canada.

An apparatus for irradiating an article with energy from an energy source includes a conveyor arranged to carry the article along four substantially parallel paths which lie one above, one below, and one on each side of the source irradiating position. The conveyor includes four substantially horizontal conveyors extending along the respective paths and transfer means for transferring the article from the first to the second conveyor, from the second to the third, etc. The radioactive source is made up of a number of radioactive pencils so arranged that they generate a cylindrical surface. The equipment is particularly adapted to irradiation of boxed produce. (B.L.M.)

37922 LIQUID TRANSFER INSTALLATION. Dufresne, Jacques; Fradin, Jean; Gaudichard, Claude; Raggenbass, Andre (to Commissariat a l'Energie Atomique). British Patent 1,115,256. May 29, 1968. Priority date Jan. 28, 1966, France.

An apparatus for transferring liquids between two receptacles closed by perforable diaphragms consists of a movable transfer bridge for location above the receptacle and bearing two hollow needles spaced apart by a distance such that it corresponds to the between-axis distance of the receptacles when the bridge is placed above them. The needles are interconnected by a tube in the bridge. The tube has an apex point. The top end of the tube is connected to valves, one of which communicates with a vacuum circuit, another with a rinsing circuit, and another with a circuit communicating with the atmosphere. The apparatus also includes a sheath for protecting each needle in the inoperative position and adapted for resting on a receptacle. Each sheath is closed by a perforable diaphragm and is pushed into the bridge, which is actuated downwards to make the needles penetrate through the sheath diaphragms into the receptacles and place the two receptacles in communication with each other. (B.L.M.)

37923 A HEAT EXCHANGER IN THE FORM OF ALUMINA BALL BEDS IN ORDER TO HEAT A HELIUM AND CESIUM MIXTURE UP TO 2000°K. Bertolini, Enzo; Gasparotto, Maurizio; Gay, Paolo; Toschi, Romano (CNEN, Frascati, Italy). Termotecnica (Milan), 22: 146-60(Apr. 1968). (In Italian).

The design, construction, and operation of a heat exchanger to be used as a heat source in an experimental installation for the study of the direct conversion of heat to electrical energy by magnetoplasmodynamic methods is described. The active part of the exchanger is constituted by a matrix of alumina balls with volume of 0.17 m^3 which is heated electrically with tungsten resistors to temperatures of 2000°K; the matrix is enclosed in a tungsten container and insulated thermally by a 10-cm thick alumina layer. The installation is mounted inside a stainless steel container and can be evacuated to a pressure below 10^{-4} mm Hg. This exchanger can heat and mix flows of helium and cesium to a temperature of 2000°K preserving the level of impurities below 100 ppM. The quantity of mix that can be heated to a temperature maintained constantly within 1.5% is 3.4 kg with a capacity up to 0.34 kg/sec. The energy accumulated in the matrix is about 1000 MJ and the thermal power of the flux reaches 2.5 MW. The exchanger has operated heating He–Cs mixtures up to 2000°K at pressures of about 4 atm, for a duration of 2000 hrs. (tr-auth)

37924 POSSIBILITY OF OBTAINING CONSTANT SUPERSTRONG MAGNETIC FIELDS. Ignatchenko, V. A.; Karpenko, M. M. (Inst. of Physics, Krasnoyarsk, USSR). Zh. Tekh. Fiz., 38: 200-4(Jan. 1968). (In Russian).

The limitations set by the mechanical strength of solenoid material to the strength of attainable constant magnetic fields are discussed. It is found that the usual assumption that the magnetic field strength cannot exceed $(8\pi s)^{\frac{1}{2}}$, where s is the tensile strength of the solenoid material, is approximately correct for a continuous solenoid, but that the actual limit to the magnetic field strength is somewhat lower. It is shown, however, that by employing a composite solenoid consisting of a number of thin coaxial sections that are not in mechanical contact with each other and appropriately selecting the radial distribution of the current, one can in principle achieve arbitrarily strong magnetic fields without stressing the solenoid beyond its ultimate strength at the expense of employing very high powers and large solenoids. A formula is derived for the optimum current distribution. The limitation imposed by cooling requirements is also considered. It is concluded, for

example, that by employing a solenoid material with a resistivity of 3×10^{-6} ohm cm and a tensile strength of 10^{10} dyne/cm^2, one can achieve a magnetic field of 7.5×10^5 Oe by expending a power of 8.5×10^8 W in a solenoid with inner and outer radii of 2.25 and 190 cm without exceeding a power density of 10^4 W/cm^3 in the solenoid. (ATD)

Heat Transfer and Fluid Flow

Refer also to abstracts 37781, 37853, 37854, 37907, 37923, 38135, and 39733.

37925 (AECL-3061) NUCLEAR STATION WASTE HEAT CAN EXTEND THE ST. LAWRENCE SEAWAY SEASON. Biggs, J. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb. 1968. 13p. (CONF-680601-25). Dep. CFSTI. CAN $0.50.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

An application of nuclear station waste heat to extend the navigation season and increase hydro-generating capacity is described. Heat requirements to limit ice formation are determined for the rivers and small lakes in the St. Lawrence Seaway System. Then predicted regional nuclear generating capacities are used to forecast the application. A first approximation of costs and benefits is made indicating a season extension may be practical. (auth)

37926 (ANL-7407) TRANSIENT COMBINED CONDUCTION AND RADIATION IN AN ABSORBING NONEMITTING MEDIUM. Heinisch, Roger P.; Singer, Ralph M.; Viskanta, Raymond (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-38. 40p. Dep. CFSTI.

Transient heat transfer by combined conduction and radiation through a plane layer of an absorbing, but nonscattering and nonemitting, stationary gray medium is considered. The solution of the resultant linear partial differential equation is obtained by an exact analytical solution in the form of an infinite series, the method of lines, and a lumped-parameter finite-difference scheme. These techniques give essentially the same numerical results. This comparison establishes confidence in the latter two methods for possible use in analyzing similar problems in which spectral and/or emission effects are accounted for. The presence of radiation as an added mechanism of energy transfer decreases the length of the transient period; an increase in optical thickness demonstrates the diffusion nature of radiation. For short times after the initiation of the transient, the solution presented is valid for the problem when the medium is a cool gas and the upper boundary is liquid. In particular, for a fluid such as sodium, where temperature profiles in film boiling are desired for short times following vaporization, this analysis can be used as a first approximation. (auth)

37927 (IN-1177) MATHEMATICAL MODEL FOR PREDICTING HEAT TRANSFER CHARACTERISTICS OF A BAYONET TUBE. Dickey, B. R.; Bendixsen, C. L. (Idaho Nuclear Corp., Idaho Falls). June 1968. Contract AT(10-1)-1230. 42p. Dep. CFSTI.

High temperature NaK circulating through a tube bundle provides the heat required for fluidized bed calcination of radioactive liquid wastes in the Waste Calcining Facility. The hot NaK flows through a central core tube before reversing flow through a surrounding annulus. Any significant transfer of heat from the core to the annulus (short-circuiting) potentially reduces the overall rate of heat transfer from the exchanger to the fluidized bed. A mathematical model was developed to predict the magnitude of the effect of short-circuiting on the heat duty of the exchanger, determine if any significant increase in exchanger duty can be realized by decreasing the short-circuiting of heat at the existing operating conditions, and to calculate any increase in exchanger duty resulting from a flow reversal of the NaK through the bayonet tube (i.e., hot NaK entering the annulus and exiting through the core). Numerical examples illustrate the heat transfer characteristics of a typical bayonet tube for a specified set of operating conditions and tube dimensions. (auth)

37928 (JUL-506-RB) DARSTELLUNG DES WAERMEUEBERGANGES IN KONZENTRISCHEN RINGSPALTEN UNTER BENUTZUNG DER ANALOGIE ZWISCHEN IMPULS- UND WAERMEAUSTAUSCH. (Representation of Heat Transfer in Concentric Ring Slots by Utilizing the Analogy Between Impulse- and Heat Exchange). Barthels, Heinz (Kernforschungsanlage, Juelich (West Germany), Institut fuer Reaktorbauelemente). Dec. 1967. 132p. (In German). Dep.

Experimental and theoretical studies were made to describe the heat transfer in turbulent flow in ring slots by using the analog between impulse and heat exchange for any Reynolds and Prandtl numbers and for all diameter ratios and heating cases. The treatment of this problem requires the knowledge of the flow magnitudes, so that the velocity distribution of the turbulent flow and the site of the velocity maximum in the ring slot were first determined. The calculated resistance coefficients and heat transfer coefficients were compared with the measured values. The experimental results are represented by working formulas which are valid for average and large Prandtl numbers. The Nusselt number depends not only on the diameter ratio but also very strongly on the Reynolds and Prandtl numbers. (J.S.R.)

37929 (SC-RR-68-133) INDUCED PRESSURE EFFECTS ON LAMINAR HEATING FOR THE BLUNT LEADING EDGE OF A FLAT PLATE IN HYPERSONIC FLOW. Bustamante, A. C. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. 61p. Dep. CFSTI.

An analysis was made to determine the effect of induced pressures on the laminar heating experienced by the hemicylindrical leading edge of a flat plate. The analysis showed that the laminar heating increased as a result of induced pressure and that this effect should be considered in the case of a shallow angle reentry of a low ballistic parameter body. This analysis was also applied to the case of a tumbling flat plate. (auth)

37930 (UCRL-14754(Rev.1)) TRUMP: A COMPUTER PROGRAM FOR TRANSIENT AND STEADY STATE TEMPERATURE DISTRIBUTIONS IN MULTIDIMENSIONAL SYSTEMS. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). May 1, 1968. Contract W-7405-eng-48. 292p. Dep. CFSTI.

The TRUMP computer program was developed to solve problems involving transient and steady state temperature distributions in multidimensional systems with arbitrary geometric configurations, initial and boundary conditions, thermal and chemical properties, modes of heat transport and production, and mass flow. Because of the general nature of the partial differential equations and the method of solution, the program may be used to solve a wide variety of boundary value, transport, potential flow, field, and other analogous problems. Thermal problems may include heat transport by conduction, free and forced convection, radiation, and mass flow. Heat may be produced or absorbed by internal heat sources and sinks, phase changes, and chemical reaction. Boundary conditions may include insulation, specified surface temperatures or heat fluxes, or heat transfer by radiation, free convection, or forced convection. TRUMP is written primarily in basic FORTRAN with a FORTRAN-II version for the IBM-7094 computer, a FORTRAN-400 version for the CDC-3600, and LRLTRAN Batch Monitor and OCTOPUS versions for the CDC-6600. (W.H.K.)

37931 (UCRL-17989, pp 253-60) CHEMICAL ENGINEERING. (California Univ., Berkeley. Lawrence Radiation Lab.).

Results of studies of heat and mass transfer between flowing gas and liquid phases are reported. Data and information are included on evaporation of pentane into flowing nitrogen and on evaporation of CS_2, pentane, cyclopentane and ethyl ether from n-tridecane. (J.R.D.)

37932 (WANL-TME-1736) TRACK: A COMPUTER PROGRAM FOR TRANSIENT AND STEADY STATE COUPLED FLUID FLOW AND HEAT CONDUCTION ANALYSIS. Lee, A. Y.; Woods, Marshall D. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jan. 1968. Subcontract NP-1. 75p. Dep. CFSTI.

A method of solution for transient or steady state analysis of a parallel channel flow system separated by heat generating solids is presented. The primary application is to perform a detailed thermal analysis of nuclear reactor components such as the reflector, the control mechanisms, and fuel cluster assemblies under various operating conditions. The method of solution may be applied to other heat transfer systems with or without internal heat generation such as heat exchange apparatus. The method employs one-dimensional, transient (or steady state) pipe flow analysis coupled with a heat conduction calculation in the solid body. The heat conduction calculation is included to determine the channel wall temperatures required to complete the hydrodynamic calculations and to provide detailed material temperature distributions. Thus, heat conduction effects between coolant channels are evaluated. The solid body geometry is general and the parallel channels may have different individual flow impedance and be arranged in any non-symmetrical pattern. TRACK, a digital computer program, was developed to perform the computations. It is written in FORTRAN IV language for the CDC-6600 computer. The program was primarily developed for transient thermal analysis but is applicable for steady state analysis. Current usage of the program is with hydrogen coolant but any fluid can be used by substituting appropriate fluid property subroutines. The formu-

lation for the transient thermal calculations is presented and the calculational models are discussed. The detailed calculational procedure is described. The input data format and a sample problem are included. (J.C.W.)

37933 HEAT TRANSFER IN LIQUID METAL. Michiyoshi, Itaru (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 9: 710-17(Dec. 1967). (In Japanese).

Developments in liquid metal heat transfer in round tubes are reported. Recent progress in the knowledge of forced convection heat transfer to liquid metals flowing through various channels is discussed. Nucleate pool boiling heat transfer is also taken up for its important position in basic heat transfer in boiling liquid metal. Particular attention is given to transient boiling. (auth)

Isotope Technology

Refer also to abstracts 37772, 38011, 38140, and 38180.

37934 (AEC-tr-6933) RADIOISOTOPES IN THE CONSTRUCTION OF FOUNDATIONS AND UNDERGROUND INSTALLATIONS. Smorodinov, M. I. Translation of Radioizotopy v Stroitel'stve Fundamentov i Podzemnykh Sooruzhenii, Atomizdat, Moscow, 1967. 200p. Dep. CFSTI.

This report was abstracted from the original language and appeared in NSA as 21: 28177. (R.C.K.)

37935 (CEA-R-3444) LE SEPARATEUR ELECTROMAGNETIQUE D'ISOTOPES: MESURES MAGNETIQUES: RESULTATS. (Electromagnetic Isotope Separator: Magnetic Measurement: Results). Boge, Marc; Baud, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1968. 15p. (In French). Dep.

The electromagnetic isotope separator of the University of Grenoble can produce isotopes with great purity. It has two magnets with an inhomogeneous field. The magnetic fields were corrected with shims in order to obtain an accuracy of $\pm 10^{-4}$ in the useful region. These shims were determined experimentally by measurements. The great enrichment factors obtained prove the quality of the apparatus. (auth)

37936 (GA-7976) ELECTRICAL PROPERTIES OF ML AND A.I.220 INSULATIONS ON 2 MIL AND 5 MIL CUPRON AND TOPHEL WIRES. Elsner, N. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 5, 1967. Contract AT(04-3)-167. 18p. (CONF-671050-1). Dep. CFSTI.

From Electrical Insulation Conference, Chicago, Ill.

Organics, organics plus Fiberglas, silicones, silicones plus ceramics, and ceramics were investigated for use as insulation suitable for 2 mil diameter cupron and tophel wires that could operate at ~470°F for 5 yrs in an Ar gas environment. The applied voltage on the insulation is 6V. The wires are to be used for the "P" and "N" legs in a radioisotope-powered thermoelectric generator designated SNAP-15 A. (F.S.)

37937 (GEMS-400) SNAP-27 QUARTERLY REPORT NO. 10, JANUARY 1, 1968-MARCH 31, 1968. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(30-1)-3535. 146p. Dep. CFSTI.

Accomplishments, schedules, liaison, and program integration of SNAP-27 into the total ALSEP/Apollo program are presented. Progress made on the Integrated Power Unit is reported including generator assembly, fuel capsule, and support equipment. Design status, thermal and structural analysis, materials procurement progress concerning the graphite LM fuel cask are summarized. The safety programs are outlined. (J.C.W.)

37938 (ORNL-4271) REVIEW OF ORNL ELECTROMAGNETIC SEPARATIONS PROGRAM, 1966-67. Love, L. O.; Bell, W. A. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 78p. Dep. CFSTI.

Research progress is reported under the following headings: stable isotopes separated, separations typifying progress in methods, isotope usage, calutron feed advancements, isotope receiver improvements, ion source development, radioactive gas separation, ion implantation, natural element contamination and problems of retention of low-abundance isotopes, sector separator, inhomogeneous-field 255° separator, and heavy-element separations. (M.C.G.)

37939 (WASH-1095) RADIOISOTOPES: PRODUCTION AND DEVELOPMENT OF LARGE-SCALE USES. (Atomic Energy Commission, Washington, D. C.). May 1968. 41p. CFSTI.

The uses of radioisotopes as sources of heat and radiation are discussed. The background, objectives, and program plans for the utilization of radioisotopes in space power systems, terrestrial power systems, thermal applications, process radiation, and space propulsion are presented. Known and projected radioisotope requirements, cost factors, and production methods which are in use or under investigation are described. (R.C.K.)

37940 PRECISE DETERMINATION OF ISOTOPIC RATIOS BY MASS SPECTROMETRY IN CASE OF ION BEAM INTENSITIES VARYING WITH TIME. Balogh, Kadosa; Kovach, Adam. ATOMKI (At. Kut. Intez.) Kozlem., 10: 45-51(Apr. 1968). (In Hungarian).

Methods usually applied in comparing ion intensities in case of beam intensities varying in time are based on a linear interpolation between results of successive measurements. The determination of the systematic error deriving from the application of these methods in the case of exponentially decreasing ion intensities is discussed. Further, it offers a possibility to set the limits of experimental conditions, under which the additional error can be kept below a given level. (auth)

37941 GAMMA ABSORPTION COEFFICIENT USED FOR SEPARATING POTATOES FROM ROCKS AND SOIL. Said-Khodzhaev, S. A. Mekh. Elek. Sots. Sel. Khoz., 11: 38-40(1966). (In Russian).

The dependence of the linear and volume coefficients of absorption on the energy of the incident γ radiation was studied for potatoes, clumps of soil and stones, in order to separate the potatoes from the surrounding media. It was found that reduction of the energy results in an increase of the probability of the photoelectric effect in proportion with the atomic number of the material. The relative attenuation of the γ radiation by the material to be separated decreases with decreasing energy and increasing thickness of the absorber. On the basis of such theoretical considerations, ^{170}Tm was chosen as the source. A simple, non-contact device was developed for the separation; in order to compensate for the dimensions, the penetrating and reflected radiations from 2, 3, and 20 mg. equiv. of radium ^{170}Tm, were used simultaneously. The reflected radiation compensated for the unevenness of the material. The device was found suitable to separate the material, without any preliminary sorting. (TTT)

37942 GAS MIXTURE SEPARATION BY THERMAL DIFFUSION COLUMN. Saxena, V. K. (Univ. of Rajasthan, Jaipur, India); Saxena, S. C. Z. Naturforsch., 23a: 471-2(Mar. 1968).

A method is described for calculating optimum pressures and maximum separating efficiencies of thermal diffusion isotope separation columns. Literature data are given on steady state separation factor for mixed isotopes related to the gas mixture pressure. It is suggested that when thermal diffusion separation is planned, preliminary measurements of steady state separation as a function of gas pressure be made on the gases to be used. (J.R.D.)

37943 METHOD FOR PREPARING RADIOACTIVE SOURCES OF SOFT X RADIATION. Danilin, L. D.; Lobov, S. I.; Pavlova-Verevkina, A. I.; Tsukerman, V. A. Radiokhimiya, 9: 743-5 (1967). (In Russian).

The preparation of stable radioactive iron sources of various configurations that are safe for handling and with strong resistance to humidity, temperature variations, and mechanical effects is described. The transparent to soft x radiation (5.9 keV) source was attached to impurity-free ceramic (steatite) backing. Two layers of ^{55}Fe with an activity of 25 to 50 mCi and 2 layers with an activity of 2.5 mCi were prepared on ceramic backing of various configurations and dimensions (in the shape of disks 11 mm in diameter, rings, and point sources with a diameter of ~2 mm). Sources with activity of 50 mCi/cm^2 were able to handle doses of 150 to 200 R/hr from 1 cm^2 surface. (R.V.J.)

37944 RADIOIZOTOPNYE METODY ISSLEDOVANIYA V INZHENERNOI GEOLOGII I GIDROGEOLOGII. (Radioisotopic Methods for Engineering Geology and Hydrology Studies). Ferronskii, V. I.; Danilin, A. I.; Dubinchuk, V. T.; Goncharov, V. S.; Polyakov, V. A.; Seletskii, Yu. B.; Flekser, N. Ya. Moscow, Atomizdat, 1968. 304p.

Data are presented on the uses of radioactive sources and tracers in resolving geological, hydrogeological, and hydrogeochemical problems. Absorption and scattering of γ- and neutron emissions and uses of radioactive probing without drilling are discussed. Radioactive tracers for developing hydrochemical prospecting methods are described and means for protection and decontamination of underground waters from radioactive wastes and fallout products are evaluated. Activation analysis and natural isotopes in engineering geology and hydrogeology are reviewed. 265 references are included. (R.V.J.)

37945 NUCLEONICS IN AEROSPACE. Proceedings of the Second International Symposium held in Columbus, Ohio, July 12-14, 1967. Polishuk, Paul (ed.). A Publication of Instrument Society of America. New York, Plenum Press, 1968. 387p. $17.50. (CONF-670714).

Fifty-one papers are included; separate abstracts were prepared for 39. Six papers were previously abstracted for NSA. For abstract numbers of individual papers see CONF-670714 in the Report Number Index. (D.H.M.)

For abstracts of individual papers see: 37699, 37700, 37760, 37949–37955, 38027, 38029–38036, 38076, 38112, 38124–38135, 38180, 38182, 38293, 38294, 39108, and 39564.

37946 SELF-LIGHTING APPARATUS. (to United States Radium Corp.). British Patent 1,111,927. May 1, 1968. Priority date Nov. 3, 1965, Switzerland.

A self-luminous light-emitting unit consists of a transparent glass body with a sealed bulb having a layer of H_3PO_4 on its inner surface, a layer of particulate phosphor adhering to the acid, and a β-emitting radioactive gas contained within the bulb. The transparent body may be coated with a layer of light-reflecting white paint except for an emission window. (B.L.M.)

37947 RADIOISOTOPE SUBLIMING SOLID PROPULSION SYSTEM. McCabe, James A. (to General Dynamics Corp.). U. S. Patent 3,373,563. Mar. 19, 1968. Filed Dec. 16, 1965.

A low thrust, secondary propulsion system that employs a radioisotope heat source for sublimation of a solid propellant to generate thrust gases is described. The device consists of a casing to define a pressure chamber and to contain the material for sublimation, a container for storage of the radioactive isotope, means for regulating the pressure of the gas generated within the chamber, and to control emission of the sublimed gas from the chamber. The container for storage of the radioactive isotope is in intimate thermal contact with the casing holding the subliming material. The subliming solid is preferably an ammonium salt or a compound of B, which effects a sufficient vapor pressure to sustain thrust at a pre-selected design temperature. (B.L.M.)

37948 IMPROVEMENTS IN OR RELATING TO HEAT RECOVERY SYSTEMS. (to Commissariat a l'Energie Atomique). British Patent 1,118,966. July 3, 1968. Priority date July 22, 1964, France.

A heat recovery system for an installation producing D_2O by the method of bithermal isotopic exchange between two fluids, one serving as a source of D_2 and the other serving as an isotope exchange medium is described. The installation includes a cold tower, a hot tower, and closed circuit means for circulating gaseous fluid between the two towers. A first liquid circuit is provided for cooling the hot gaseous fluid at the output of the hot tower in an indirect heat exchanger and for transferring this heat to the cold gaseous fluid before this cold fluid enters the hot tower in a direct contact exchanger arranged before the input of the hot tower. A second liquid circuit is provided for removing the remaining heat energy from the gaseous fluid in direct contact exchanger before the fluid enters the cold tower and for transferring the remaining heat energy by means of an indirect liquid to liquid exchanger to a third liquid circuit, which also serves the exchanger having direct contact arranged before the input of the hot tower. (B.L.M.)

37949 RADIOISOTOPE SURVIVAL SUIT HEATER. Shivers, Rufus W. (Atomic Energy Commission, Washington, D. C.). pp 194-9 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

One of the basic water hazards to the swimmer is low temperatures. This is also the case with downed pilots in frigid waters. Several methods are being currently examined for keeping the swimmer warm. The two most promising are: an electrical resistance-wire heating system with a silver zinc battery operating off an umbilical cord for power and a radioisotope heated fluid suit. The development of a radioisotopic heater unit for such a system is discussed. Approximately 350 to 500 thermal watts must be supplied to the swimmer. This development is described. (auth)

37950 AEROSPACE NUCLEAR SAFETY ANALYSIS OF A Pm_2O_3 RADIOISOJET THRUSTER. Parker, Andrew J. Jr. (Hittman Associates, Inc., Baltimore); Pyatt, David W.; West, William S. pp 112-29 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Interplanetary probes and earth-orbiting satellites require a propulsion capability to maintain both attitude control and to provide linear velocity increments for orbital corrections and/or interplanetary transfer trajectory corrections. Missions to Jupiter and beyond have been proposed for the 1970's to study galactic space with the ultimate aim of understanding the physics of the solar system. Small thrusters presently considered for spacecraft propulsion applications are generally classed as hot gas or cold gas-type systems. The principle of the cold gas system is to expand high pressure gas from a gas reservoir through a nozzle while the hot gas system utilizes a heat source in conjunction with a nozzle to expand the gas. The application of a nuclear heat source and its suitability to meet reasonable aerospace nuclear safety criteria when incorporated into a pulse jet thruster design is discussed. (auth)

37951 RADIOISOTOPES AS ZERO POWER SOURCES OF X RAYS FOR X-RAY DIFFRACTION ANALYSIS. Toothacker, William S.; Preuss, Luther E. (Edsel B. Ford Inst. for Medical Research, Detroit). pp 341-3 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The possibility of substituting an isotopic source of x rays for a standard tube for the purpose of x-ray diffraction analysis is examined. The possibility of application for lunar diffraction equipment is especially interesting since then the need for a very precisely regulated voltage supply for the tube and accoutrements would be eliminated. An Fe-55 source was chosen for the initial experimental work. The intensities achieved were of the order of 12 counts per minute with a resolution of 2° full width at half maximum intensity. Success with powder samples of NaCl and LiF has been reported. With a single crystal of LiF, resolution of 0.29° FWHM with an intensity of 1400 counts per minute was recorded when the aperture widths were reduced. Intensities of up to 2700 counts per minute have been recorded. This resolution appears to be adequate for the proposed lunar diffraction work. (auth)

37952 RADIOISOTOPE HEATER FOR A SILVER-ZINC BATTERY. Levy, I. Marshall; Bustard, Thomas S. (Hittman Associates, Inc., Baltimore). pp 200-7 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The use of a radioisotope heater is shown to be feasible as a heat source for maintaining silver–zinc battery temperatures in a low ambient environment. The advantage of this concept is a significant reduction in battery size and weight. After selection of an isotope and heat source (fuel capsule) design analysis, a conceptual design of a compact silver–zinc battery heated by a radioisotope is established. (auth)

37953 APPLICATION OF RADIOISOTOPES FOR AEROSPACE WASTE RECLAMATION AND WATER SYSTEMS. Metzger, Courtney A. (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio); Hearld, Albert B.; Reynolds, Bobby J.; Shivers, Rufus; Murray, Robert W. pp 208-15 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The use of radioisotopic heat sources in space vehicle life support systems is shown to be preferable to other types (electrical or liquid) of heaters. Vacuum distillation-vapor pyrolysis and vacuum distillation-vapor filtered water recovery processes produce potable and sterile water from urine. Recovery efficiencies (urine in versus water out) are good, averaging 93% for the two longest runs. Liquid level controls proved to be the most difficult problem in the water recovery systems. Simplified methods with minimal electronics proved to be the best approach. Urine solids are extremely abrasive and require special handling procedures. The solids are detrimental to seals, bearings and close tolerance devices. Static phase separators in the urine evaporator are preferable to dynamic devices because of power considerations and the abrasive characteristics of the urine solids on moving parts. Although a catalytic oxidizer was not incorporated in the vapor filter system, good quality water was obtained utilizing only carbon. The addition of a catalytic burner will further improve the quality of water. (auth)

37954 KRYPTON POTENTIAL IN AEROSPACE. Figueroa, C. G. (Industrial Nucleonics Corp., Columbus, Ohio). pp 230-4 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The krypton potential in aerospace can be divided into two major fields of interest. First, there is the utilization of ^{85}Kr gaseous sources in the aerospace isotope applications field. These applications cover diverse fields such as oil gaging, gamma communi-

cations systems, bremsstrahlung sources, etc. Second, there is the potential for the application of kryptonate technology in aerospace systems and materials research. The kryptonate applications also cover diverse fields such as temperature measurement, chemical sensors, fatigue detection, wear and corrosion measurement, etc. The second potential aspect of ^{85}Kr utilization under the generic form of kryptonates is of a more recent development, but nevertheless offers the promise of surpassing the potential for the utilization of gaseous sources. The possibilities of utilizing the kryptonate technique for the detection of fatigue are discussed. The study of fatigue, which involves the production of lattice defects, dislocations and vacancies, might consequently lead to a change in the degree of ^{85}Kr absorption by host material. Another possiblity is that a kryptonated material that has undergone a fatigue treatment with its consequent lattice alterations, will release some of the ^{85}Kr previously held in its lattice, in comparison with a non-fatigued specimen. A third possibility lies in the alteration of the temperature release characteristic of the kryptonated material as a function of fatigue. The temperature release characteristic of four specimens was studied as a function of different thermal stress levels. The results indicated a deviation from the expected temperature release curves. In a second experiment, the temperature release characteristics of aluminum samples were studied as a function of mechanical fatigue loading. The non-fatigued population showed the same uniform percentage retention after a constant temperature exposure for a given period of time. The fatigue population showed a scatter distribution on the degree of ^{85}Kr retention under the same experimental conditions. Since the experiment was carried out under controlled conditions so that the only variable was the mechanical loading of one group of specimens, it has been postulated that the scatter of the second set of data is indicative of various degrees of fatigue loading of fatigue specimens. (auth)

37955 EFFECT OF SPACE CHARGES ON THE HIGH-TEMPERATURE FATIGUE OF NICKEL. Martin, George; Tsang, Schilling (North American Aviation, Inc., Los Angeles). pp 235-53 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The rate of many surface reactions, including oxidation, is controlled by the rate of diffusion of the reacting species. An external electric field generating a current through the reaction layers will affect this ion movement and hence the reaction rate. The purpose of the present experiment was to demonstrate that this effect on reaction rate will also influence surface sensitive properties of metals such as fatigue. The space charge was generated by a potential of 1000 V/cm and external ionization from a 25,000 Ci ^{60}Co source. Experiments were carried out by means of torsion fatigue tests of nickel at 1500°F. Space charge currents obtained were about 10 microamp/cm^2 with the use of external ionization as compared to about 0.15 microamp/cm^2 with the electric field alone. The fatigue life with maximum ionization in a negative field was about 25 percent longer than with maximum ionization and positive field polarity. (auth)

Materials Testing

Refer also to abstracts 37913, 37914, 38125, 38126, 38165, and 38166.

37956 NON-DESTRUCTIVE DETECTION OF SURFACE CRACKS ON MACHINE PARTS BY MEANS OF AUTORADIOGRAPHY. Frynta, Zdenek; Rosicka, Vlasta (National Research Inst. for Materials, Prague). Jad. Energ., 14: 69-70(Feb. 1968). (In Czech).

Determination of surface cracks on uneven surfaces is described based on the use of autoradiographic stripping film. The parts to be examined are immersed into a solution labeled with ^{32}P or ^{35}S. After cleaning and drying the machine part the stripping film is applied onto its surface. After developing the film dark cracks are visible on the autoradiograph. (auth)

37957 NONDESTRUCTIVE INSPECTION BY NEUTRON RADIOGRAPHY. Burkdoll, F. B. (Explosive Technology, Fairfield, Calif.). Space/Aeronaut., 49: 117-23(May 1968).

Use of the nuclear test reactor at the Vallecitos (California) Nuclear Center for inspection of aircraft ordnance devices by neutron radiography is discussed and compared with x-ray techniques. Neutron radiographs measuring 14 by 17 in. are now produced routinely at the Vallecitos facility. In neutron radiography, a beam of well-collimated thermal neutrons is passed around and through an object. By virtue of spatial intensity modulation, the beam on the far side of the object carries information about the object's internal structure and composition. The spatial flux variation is recorded by an imaging system. The neutrons can penetrate relatively substantial objects. Portable nonreactor neutron sources have been used to make radiographs, but these have been inferior in resolution to radiographs from reactor sources, largely because of the poor collimation characteristic of low neutron fluxes. The radioactivity induced in samples by neutron bombardment is slight, and no special precautions need be taken in handling them. (BBB)

37958 NUCLEAR METHODS OF WIDTH CONTROL IN LAY-FLAT TUBE PRODUCTION. Kemper, A.; Platzek, P. (TNO, Delft, Netherlands). Brit. Plast., 41: 115-20(June 1968).

Closer width control of layflat tube employed for packaging is becoming increasingly important with the growing use of more sophisticated automated packaging equipment and techniques. Mechanical control by contact methods has proved inaccurate, mainly due to the deformability of the film edges, while optical methods are unsatisfactory with transparent or translucent materials. The method described employs radioactive radiation sources (^{14}C), so that measurement is contact-free. Results are independent of environmental influences, color differences, and surface properties of the film. Lateral film displacement on the guiding rolls does not affect the precision of measurements. The technique can be applied to all kinds of material, provided the surface weight exceeds 5 mg/cm^2. (auth)

37959 RADIATSIONNAY DEFEKTOSKOPIYA. (Radiation Defectoscopy). Rumyantsev, S. V. Moscow, Atomizdat, 1968. 560p.

Data are given on the physical principles of the uses of ionizing radiation in defectoscopy and material control. X-ray devices, betatrons, γ-installations and other radioactive sources are discussed as well as the methods and techniques used in testing the quality of casted, welded, and soldered materials. The problems of personnel safety and of handling radioactive materials are also discussed. The influence of various defects on mechanical properties of examined instruments and various problems of radiation defectoscopy are analyzed. 220 references and 32 nomograms are included. (R.V.J.)

37960 RADIOACTIVE STUDY OF ABRASION CAUSES FOR VERTICAL TEARS IN TWO OIL LUBRICATOR FLAT STEEL DISCS. Brendel, H. (Technische Hochschule, Karl-Marx-Stadt, Ger.); Wagner, K. Wear, 11: 277-90(1968). (In German).

An iron plate was neutron activated to specific activities of about 1 mCi/g of ^{59}Fe and ^{51}Cr. The lapped surface (about 14 cm^2) of this plate was pressed against a lubricated non-radioactive iron plate in a loading equipment. Then the radioactive piece was torn from the non-radioactive plate by a shearing apparatus with high shear velocity. After this process there was some radioactive material on the surface of the non-radioactive inserted plate and in the residues of lubrication oil which were washed from the radioactive plate, thus showing that wear occurs. The experiments demonstrated that the separation of radioactive material is caused by the shearing process, not by loading, corrosion or unintended tangential displacement of the plates. The investigations were concerned with the effect of shear velocity and lubrication oil on wear. The results confirm a prediction made by Pietsch from an experimentally established equation $\sigma_s t_z$ = const. (σ_s = shear stress, t_z = shear time). According to that prediction, the volume tensile strength of a lubrication oil film in the case of high shear velocities can become as high as the tensile strength of microregions of the metal. Radioautographs of the non-radioactive inserted plate showed such a behavior only for a few spots distributed irregularly over the surface. (auth)

Protective Structures

37961 (AD-664439) FALLOUT SHELTERS. (Office of Civil Defense, Washington, D. C.). Dec. 1967. 8p. (OCD-TR-39). CFSTI.

Technical information and references on fallout shelter design are presented for the convenience of design professionals. This information is supplemented by publications and by the architectural and engineering services which are described. (USGRDR)

37962 (AD-664478) FALLOUT SHELTER SURVEYS: GUIDE FOR ARCHITECTS AND ENGINEERS. National Plan Appendix Series. (Office of Civil Defense, Washington, D. C.). May 1960. 54p. (OCD-NP-10-2). CFSTI.

A guide is presented to provide architects and engineers with procedures and standards for evaluating the fallout shelter potential of existing structures, and modifying structures from the standpoint of radiation shielding and habitability to improve their worth as fallout shelters. These same procedures and standards may be used for preliminary design to incorporate shelter into new structures. (auth) (USGRDR)

37963 (AD-664479) CIVIL ENGINEERING IN A NUCLEAR ENVIRONMENT. (Office of Civil Defense, Washington, D. C.). June 1964. 70p. (CONF-56-2). CFSTI.

From American Society of Civil Engineers Environmental Engineering Conference, Atlanta.

Topics discussed include: design of simple structures for moderate levels of blast resistance; engineering in a thermal environment (warfare resistance and reusability of buildings; thermal radiation from nuclear explosions); and engineering in a fallout environment (fundamental concepts in fallout shelter and fallout problems in civil defense). (USGRDR)

Radioactive Material Handling

Refer also to abstracts 37691 and 37831.

37964 RADIOACTIVE MATERIALS HANDLING AND TRANSPORT SYSTEM. Baudiffier, Guy; Bazzoni, Dino; Cauwe, Juste; Lecoq, Jean-Pierre (to European Atomic Energy Community). British Patent 1,119,621. July 10, 1968. Priority date Dec. 22, 1964, Belgium.

A lead castle system for handling and transporting radioactive materials is described. The mechanism is designed to remove a specimen or fuel element from a nuclear reactor channel and transport it in the shielded container which gives biological protection against alpha contamination and gamma irradiation. A mechanism in the design provides foolproof chronological sequence of steps of opening and closing the various protections. (J.C.W.)

Vacuum Engineering

37965 (UCRL-17845) MEASUREMENT OF OMNITRON CRYOPUMPING AND OUTGASSING BY 10^{-16} TORR PULSE COUNTING MASS FILTER. Milleron, Norman; Wolgast, Richard; Nitschke, Joachim M. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 13p. (CONF-680401-4). Dep. CFSTI.

From 4th General Meeting on International Organization for Vacuum Science and Technology, Manchester, England.

The Omnitron is a new type of synchrotron accelerator with a storage ring that will deliver beams of light and/or heavy ions to different experiments almost simultaneously. Storage of heavy ions in a high charge state for 20 msec requires that the vacuum environment be assessed more carefully than can be done by the sum of the partial pressures convention. A crude figure of merit, $10^{14} \leq N \cdot \Sigma n_i Z_i^2$ is used where: $N = 3 \times 10^7$ turns around the accelerator, n_i = the concentration of atoms of the i^{th} atomic number Z_i. To ensure that this figure of merit is met, outgassing from materials and pumps and pumping speeds are assessed by counting ions from a quadrupole mass filter that can indicate average concentrations of light gas to $<10^{-16}$ torr and $<10^{-15}$ torr of ions with m/e up to 500. Using this together with an accumulation method, contamination coming from oil D.P. and M.P. systems having special LN traps and valves is shown to be negligible. For the 7" D.P. system, no m/e > 44 could be detected at an average sensitivity of 10^5 molecules/sec. An average of 10^8 molecules/sec with m/e > 44 were detected coming from the M.P. system. A 304-type stainless-steel tube, 3 in. dia. × 0.065 in. wall × 17 in. length cleaned in a chemical process made by the Diversey Co., was pumped down to the Omnitron figure of merit in <5 hrs (without bakeout or cooling) using 4°K cryopumping and the clean D.P. system. (auth)

37966 PREHEATER FOR DIFFUSION PUMP. Lucas, Luther R.; Reimers, Richard M. (to United States Atomic Energy Commission). U. S. Patent 3,391,857. July 9, 1968.

A high vacuum diffusion pump which has valves for isolating the boiler from the vapor jet-forming structure during a warm-up period is described. Also, means for using vapor from the boiler to preheat the jet forming structure so that the jets function efficiently and without backstreaming immediately after being turned on are described. (AEC)

37967 ION PUMPS. Pontvianne, J. Ann. Radioelec., 23: 171-9(Apr. 1968). (In French).

A general introduction on ultrahigh vacuum and means employed for its production and measurement, and a short exposition of the working principles of ion pumps are presented. The principal types of ion pumps and indications of their performance and conditions of use are also reviewed. Results of measurements are given and discussed. (auth)

37968 HIGH TEMPERATURE CEMENT FOR BONDING SUBSTRATES IN ULTRAHIGH VACUUM. Seitchik, J. A.; Stein, B. F. (Sperry Rand Corp., Philadelphia). Rev. Sci. Instrum., 39: 1062-3(July 1968).

Methods and materials for deposition of thin films on substrates to be bonded in vacuum are described. Maintenance of substrate at uniform temperature and accurate measurement of this temperature are required. Results obtained using a heater block technique in which the substrate is bonded to the block using conductive silver pigmented acyloid cement are described. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 37781.

General Detectors and Monitors

Refer also to abstracts 38142, 38362, 39506, and 39564.

37969 (AAEC/TM–450) APPRAISAL OF THE A.A.E.C. TILTING CHAIR GEOMETRY FOR MEASURING LOCALISED AND DISTRIBUTED BURDENS OF RADIOISOTOPES IN THE HUMAN BODY. Jack, G. C.; Parsons, D. E.; Casey, Anna L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1968. 24p. Dep.

The tilting chair used at Lucas Heights for whole body counting of personnel has been studied in order to obtain quantitative data on variation of counting efficiency with gamma energy and source position in the body. A technique for calculating this variation was tested by comparing calculated results with directly observed experimental results for two different phantoms and three different organs. The method allows greater accuracy in extending phantom calibration data to people of varying sizes. The apparent movement of the gamma photopeak position is briefly examined. Results indicate that, apart from the limitation placed on identification of energy by the resolution of the crystal, use of the chair geometry further limits the exact determination of energy. (auth)

37970 (AE-319) AN ON-LINE WATER MONITOR FOR LOW LEVEL β-RADIOACTIVITY MEASUREMENTS. Quirk, E. J. M. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1968. 26p. Dep.

A detection system is described for the continuous monitoring of β-radioactivity in the secondary cooling water at the Studsvik R2 reactor. Radiation emanating from a water surface is measured by a large area gas proportional detector. To protect the detector from splash caused by bursting bubbles a protective film and heater assembly is interposed between the detector and the water surface. A special feature is the programmed "exercise" sequence for the magnetic valves which eliminates a tendency for them to stick after prolonged periods of idleness. The extent to which contamination affects the background counting rate has been studied. It is shown that for the duration of the tests described the monitor remains free from the effects of contamination so long as the scaler live time is suitably chosen. Minimum measurable specific activities obtainable in practice extend from $4 \cdot 10^{-6}$ to $3.86 \cdot 10^{-8}$ Ci/m^3 depending on the β end-point energy in the range 167 keV to 2.26 MeV. (auth)

37971 (AI-AEC-Memo–12706) LOAD-SENSITIVE, LOW NOISE PULSE PREAMPLIFIER FOR USE WITH SEMICONDUCTOR DETECTORS OF NUCLEAR RADIATION. Langrod, K. (Atomics International, Canoga Park, Calif.). May 24, 1968. 9p. Dep. CFSTI.

The design and construction of a novel preamplifier for semiconductor detectors is described that has a stability of output increased by an order of magnitude, as compared with a common voltage preamplifier. (auth)

37972 (ANL-Trans–623) PULSE DIVISION CIRCUIT FOR USE WITH POSITION-SENSITIVE DETECTORS. Kuhlmann, W. R. (Cologne Univ. (West Germany). Institut fuer Kernphysik). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report BMwF-FBK–67–61. 16p. Dep. CFSTI.

For experiments with detectors which give an analog information about the spot where the particle has entered the detector, an electronic pulse division circuit is evaluated. The circuit derives an output pulse $U_Q \sim \ln (U_1/U_2)$ from two coincident input signals U_1 and U_2. These may vary in a range $1.0\ V \leq U_2 \leq 10\ V$ while (U_1/U_2) varies from 1.2 to 4.0. The output pulses may be analyzed directly by a pulse-height-analyzer. (auth)

37973 (CEA-R-3320) NOUVEAUX TYPES DE CHAMBRES A ETINCELLES DESTINEES A LOCALISER DES CORPS RADIOACTIFS EMETTEURS DE RAYONS X OU γ ET LEUR APPLICATION EN MEDECINE. (New Types of Spark-Chambers for Imaging γ or X Emitters, and Their Medical Applications). Leloup, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 120p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

In order to adapt spark-chambers to low-energy particles, a first attempt was made using a two-electrode device operating as a proportional counter. The signal obtained triggers a high-voltage pulse which is applied to the same device and a spark occurs near the track of the particle. A three-electrode device including a detection space associated to the sparks space was then used. The spark was formed spontaneously at the point where the particle passed when suitable direct-current voltages were applied to the electrodes; the high voltage is slightly lower than on the other types of chamber. This phenomenon makes the three-electrode device very easy to use for X or γ rays. The characteristics of the first device filled with argon and methane are given and the first results obtained in the medical field with a device filled with xenon methylal are presented. (auth)

37974 (CNEA–206) ENSAYOS DE DERIVADOS DE BORAZINA Y BORAZARENOS COMO CENTELLADORES PARA NEUTRONES LENTOS. (Tests of Derivatives of Borazine and Borazarenes as Scintillators for Slow Neutrons). Molinari, M. A.; Rojo, A. E.; Videla, G. J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1967. 18p. (In Spanish). Dep.

B-tri-(diphenyl)-N-trimethyl borazine, B-tri-(diphenyl)-N-triphenyl borazine, B-tri(α-naphthyl)-N-trimethyl borazine, bis-2,1-borazaro-2-naphthyl ether, and 9,10-dihydroxy-borazarophenanthrene in benzene solution and as fine solid heads were tested as counters of thermal neutrons from the reaction ^{7}Li(d,n)^{8}Be moderated with paraffin in the presence of a γ background. Measurements were made of the absolute flux of neutrons and γ radiation using activation of indium foils and γ spectrometry. Characteristic counting curves and efficiency curves with various solid and liquid scintillators were obtained. Studies were made on the effects of concentration and geometric and dimensional factors, using a source of Po–Be and Ra–Be. Tests were also made in a critical assembly with excellent results. (tr-auth)

37975 (CONF-670545) GEMEINSAME TAGUNG UEBER HALBLEITERDETEKTOREN IN STRAHLENSCHUTZ UND STRAHLENMESSTECHNIK VOM 11. BIS 13. MAI 1967 IM INSTITUT FUER STRAHLENSCHUTZ DER GESELLSCHAFT FUER STRAHLENFORSCHUNG NEUHERBERG BEI MUENCHEN. (Joint Meeting on Semiconductor Detectors in Radiation Protection and Radiation Measurement Techniques from May 11–13, 1967, at the Institute for Radiation Protection of the Society for Radiation Research, Neuherberg, Munich). (Societe Europeenne de Protection Contre les Rayonnements). 227p. (In German). Dep.

Separate abstracts were prepared for each of the twenty-three papers presented. (B.G.D.)

For abstracts of individual papers see: 37976–37989, 38059–38064, 38098, 38099, and 38138.

37976 (CONF-670545, pp 7-16) WIRKUNGSWEISE UND PHYSIKALISCHE EIGENSCHAFTEN VON HALBLEITERDETEKTOREN. (Operational Principles and Physical Properties of Semiconductor Detectors). Staeudner, R. (NUCLETRON, Gesellschaft fuer Nucleonic und Electronic mbH, Munich (West Germany)). (In German).

The requirements placed on semiconductor detectors are outlined. The physical properties of germanium and silicon are summarized. The p-n transitions in semiconductors are described and the calculation of the density of the space-charge zone, field strength, rise time, and capacity is illustrated. Various detector types are described and examples are given of their application. (J.S.R.)

37977 (CONF-670545, pp 17-35) DIE FESTKOERPERANALOGA ZU DEN KLASSISCHEN, GASGEFUELLTEN STRAHLUNGSDETEKTOREN. (Solid-State Analog to the Classical Gas-Filled Radiation Detectors). Ruge, I. (Technische Hochschule, Munich (West Germany). Institut fuer Technische Elektronik). (In German).

The solid-state analog to the ionization chamber is described and some special models of solid ionization chambers are given. Two detectors are presented, which are the first results of studies to obtain solid-state detectors with internal amplification by a charge carrier multiplication. These detectors were prepared in order to verify the solid-state analog to the proportional counter and to the G-M counter. (J.S.R.)

37978 (CONF-670545, pp 36-56) DIE ELEKTRONISCHE VERARBEITUNG VON IMPULSEN AUS HALBLEITER-DETEKTOREN. (Electronic Processing of Pulses From Semiconductor Detectors). Stanek, F. W. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). (In German).

Beginning with a radiation-induced pulse in a semiconductor detector, the theory of the charge-sensitive preamplifier (charge-

voltage converter) was treated, in which the effects of the transient statistical pulse sequence, the nonlinearity of the amplifier, and the noise on the spectral resolution capability was introduced. The further processing of the pulse, possible deterioration of the spectral resolution, and measurement errors caused by the following electronics were also considered. (tr-auth)

37979 (CONF-670545, pp 57-61) DIE THEORETISCHE GRENZE DER ENERGIEAUFLOESUNG VON FESTKOERPER-IONISATIONSKAMMERN AM BEISPIEL DES Ge(Li)-DETEKTORS. (Theoretical Limits of the Energy Resolution of Solid-State Ionization Chambers, Using Ge(Li) Detectors as an Example). Eichinger, P. (Technische Hochschule, Munich (West Germany). Institut fuer Elektronik). (In German).

Various models describing electron–hole pair formation in semiconductor detectors by charged particles and gamma radiation are discussed. Factors which limit the resolution of semiconductor detectors such as pulse rise-time and background and the Fano factor are described. For a lithium-drifted germanium detector with a Fano factor ≤0.2 the attainable energy resolution at half maximum intensity is 1.8 keV for 1 MeV particles (~0.2 percent) and 5 keV for 10 MeV particles (~0.05 percent). (W.H.K.)

37980 (CONF-670545, pp 73-80) BESTIMMUNG VON TEILCHENORT UND TEILCHENENERGIE MIT GRENZSCHICHTZAEHLERN. (Determination of Particle Position and Particle Energy With Surface-Barrier Counters). Festag, J. G. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). (In German).

The set-up for the determination of particle position and energy using surface-barrier counters is described. The results obtained with Am and ThB sources are given and discussed. (J.S.R.)

37981 (CONF-670545, pp 81-7) MESSUNG GERINGSTER AKTIVITAETEN MIT HALBLEITERDETEKTOREN. (Measurements of the Lowest Activities With Semiconductor Detectors). Kuhn, L. (Frieseke und Hoepfner G.m.b.H., Erlangen-Bruck (West Germany)). (In German).

The application of semiconductor detectors to the measurement of very low level α, β, or $\alpha-\beta$ activities is discussed. The zero effect radiation is considered in unshielded and shielded counters. The relative γ sensitivities of semiconductors detectors are considered. (J.S.R.)

37982 (CONF-670545, pp 96-106) CONSTRUCTION AND USE OF SEMICONDUCTORS FOR RADIATION PURPOSES. Roman, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)).

The surface-barrier detectors prepared from n-type silicon (300–9000 ohmcm) with active area up to 4.5 cm^2 were used for spectroscopic and total activity measurements. The spectra of low energy beta emitters are presented. A special low background anticoincidence silicon counter has been constructed. A shallow silicon surface-barrier detector was used as an extrapolation ion chamber, for beta surface dose rate measurement. The counting efficiency and the background counts of silicon detectors were measured. (auth)

37983 (CONF-670545, pp 109-15) EIN FESTKOERPER-AUSLOESEZAEHLER NACH DEM GM-PRINZIP. (Solid-State Release Counter Based on the GM Principle). Feulner, W. (Technische Hochschule, Munich (West Germany). Institut fuer Elektronik). (In German).

The solid-state counter can be considered an analog to the GM tube. Its construction and operational principles are outlined and illustrated. The pattern of the probability density for the pulse length, the pulse screen images, and the exponential dependence of the mean pulse length on the pulse current are shown. The counting rate behavior of the solid-state release counter is determined. A block diagram is given of the pulse length control circuit. (J.S.R.)

37984 (CONF-670545, pp 126-36) BISHERIGE ERFAHRUNGEN UEBER MEDIZINISCH-BIOLOGISCHE ANWENDUNGEN VON MINIATUR-HALBLEITER-DETEKTOREN. (Previous Experiences on Medical–Biological Uses of Miniature Semiconductor Detectors). Pfeiff, H. (Giessen Univ. (West Germany). Wilhelm-Conrad-Roentgen-Klinik). (In German).

A miniature surface-barrier counter was developed for biomedical studies in living tissues. The temperature dependence of the noise of the counter was measured. For illustration the energy spectra of ^{32}P and ^{35}S at various detector temperatures were given. The current-voltage curves of miniature semiconductor detectors were also determined at different temperatures. A scheme was given for the simultaneous measurement of two radioactive nuclides in two channels. (J.S.R.)

37985 (CONF-670545, pp 137-44) VERGLEICH ZWISCHEN GRENZSCHICHTZAEHLERN UND DIFFUNDIERTEN ZAEHLDIODEN. (Comparison Between Surface-Barrier Counters and Drifted Counter Diodes). Glasow, P. (Firma Siemes AG, Erlangen, Ger.). (In German).

A review is given of the latest methods for the preparation of surface-barrier counters and drifted counter diodes. The properties of the two semiconductors are briefly compared. (J.S.R.)

37986 (CONF-670545, pp 156-63) EINIGE γ-SPEKTREN AKTIVIERTER ZYKLOTRONTEILE. (Some γ-Spectra of Activated Cyclotron Parts). Festag, J. G. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). (In German).

The use of a Ge(Li) detector for the detection and determination of the radio-induced activity of cyclotron parts was described. The results obtained were compared with those obtained using a NaI(Tl) crystal. The comparison showed that with a Ge(Li) detector the long-lived activities important for radiation protection problems can be detected or separated much earlier than with NaI(Tl) crystals. (J.S.R.)

37987 (CONF-670545, pp 164-70) HALBLEITERSPEKTREN VON URAN-SPALTPRODUKTGEMISCHEN. (Semiconductor Spectra of Uranium Fission Product Mixtures). Petri, H.; Riepe, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). (In German).

For routine determination of fission products (burn-up measurements) or fission gases (released in fuel elements) with scintillation counters, the spectrometry with Ge(Li) detectors as preorientation was tested. The higher resolution permits a survey on the effect of perturbing lines. If the activity or measurement duration permits, more data can be obtained by the exchange of a scintillation counter with a Ge(Li) detector. For illustration, Ge(Li) spectra of fuel elements under various conditions of burn-up, decay time, and cladding materials and spectra of fission gases for various decay times were given. (tr-auth)

37988 (CONF-670545, pp 178-84) BESTIMMUNG DER ENERGIEVERTEILUNG VON RUECKSTOSSPROTONEN IN WASSERSTOFFHALTIGEM MATERIAL BEI NEUTRONENBESTRAHLUNG. (Determination of the Energy Distribution of Recoil Protons in Hydrogen-Containing Material in Neutron Irradiation). Hacke, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). (In German).

The extent to which semiconductor detectors are applicable to the dose determination of fast neutrons in tissues was investigated. The advantages of semiconductor detectors are their small volume and the possibility of determining directly the energy spectrum of recoil protons in tissue and the LET distribution. The recoil proton spectrum, measured with a Si semiconductor detector, was determined in dependence on the energy. The spectra of recoil protons in polyethylene of various thickness at the same neutron flux was also measured. The spectra of recoil protons in polyethylene and tissue-equivalent materials at the same neutron flux were compared. The distribution functions of the recoil proton fluxes and the energy dose were determined. The energy dose per unit flux was measured in dependence on the depth. The LET spectrum of the energy dose at various depths of a water phantom was measured. (J.S.R.)

37989 (CONF-670545, pp 191-9) VERWENDUNG VON KLEINEN HALBLEITERDETEKTOREN ZUR DIREKTEN MESSUNG VON NEUTRONENFLUSSPROFILEN IM REAKTORKERN BEI NULLEISTUNGSEXPERIMENTEN. (Application of Small Semiconductors to the Direct Measurement of Neutron Flux Profiles in the Reactor Core in Zero Power Experiments). Henning, K.; Tauffenbach, H.-J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany). Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany)). (In German).

The direct measurement of the neutron flux with very small semiconductor detectors was proposed for zero power experiments with the FDR. The detector arrangement used is described and the principal circuit of a 20-channel installation is given. The advantages of the experimental arrangement with respect to interference safety are described. The differential pulse height distribution of a semiconductor detector was determined. The results show that semiconductor can be used advantageously in those reactors having sufficient space between the fuel rods for the detectors. (J.S.R.)

37990 (KAPL-3412) TRACK DENSITY MEASUREMENT IN DIELECTRIC TRACK DETECTORS WITH SCATTERED LIGHT. Schultz, Warner W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 1968. Contract W-31-109-eng-52. 13p. Dep. CFSTI.

Fission track densities in glass and in Lexan polycarbonate resin have been measured using light scattered from the tracks

as a measure of the track density. Scattered light was found to be proportional to track density up to the point where tracks begin to overlap. For the two track detector materials tested, a scattering angle was found at which optimum signal-to-background ratios are obtained. (auth)

37991 (N-68-11367) RUGGEDIZED THIN-WINDOW PROPORTIONAL-COUNTER TUBE. Schnopper, Herbert W.; Shields, Rex A. (Jet Propulsion Lab., Pasadena, Calif.). Sept. 15, 1967. Contract NAS7-100. 7p. (NASA-CR-90428; JPL-TM-33-221). CFSTI.

The design and testing of a thin-window proportional-counter tube are described. The objective of this investigation was the development of a component suitable for use in space experiments involving the detection of x rays from light elements. The stability, efficiency, and resolution of the tube described here are consistent with space-application requirements. In a series of tests, it was determined that 0.25-mil aluminum-coated Mylar, supported by a nickel screen, provided maximum strength with minimum absorption. Two methods of sealing the window are described: an O-ring and a potting compound. Sodium Kα pulse-height distributions from the thin-window tubes are compared with those from a standard commercial tube having a mica window. (auth) (STAR)

37992 (N-68-11787) ANNULAR LITHIUM-DRIFTED GERMANIUM DETECTOR FOR STUDYING NUCLEAR REACTION GAMMA RAYS. Levy, Arthur J. (Virginia Univ., Charlottesville). Aug. 1966. 132p. (NASA-CR-90545). CFSTI.

Thesis.

Lithium-drifted germanium gamma detectors were fabricated in the form of 1" long annular cylinders with a $^3/_{16}$" diameter coaxial hole. Fabrication techniques and testing procedures for the detectors are detailed. The efficiencies of these annuli were measured at energies from 0.5 to 9 MeV. The effect of source distance, h_γ, on intrinsic photoefficiency was measured. Graphs of intrinsic efficiency vs. E_γ for the photopeak, double-escape peak, and single escape peaks are presented as well as graphs giving ratios of double-escape to photopeak efficiency vs. E_γ, full-energy to single escape efficiency vs. E_γ, and double-escape to single-escape efficiency vs. E_γ. One such Ge(Li) annulus was used as the center crystal of a three crystal spectrometer to study the ^{24}Mg gamma decay following the ^{23}Na(d,n)^{24}Mg reaction. The deuteron bombarding energy was 0.990 MeV. Of the 64 observed transitions attributed to the decay of ^{24}Mg, 35 of these are unreported in the literature. One-hundred and three additional transitions remain unidentified. The ^{24}Mg states at 9.5 MeV (4^+, 6^+) and 8.44 MeV are observed to be doublets as was suggested by Ollerhead, et al., at Chalk River. The measured energies of these doublets were 9528 ± 3 keV, 9508 ± 7 keV and 8437 ± 4 keV, 8424 ± 3 keV. The use of a Ge(Li) detector permitted clear observation of many of the transitions so that branching ratios previously reported by Endt and Van der Leun have been refined. (auth) (STAR)

37993 (N-68-21647) APOLLO RADIATION SURVEY METER AND PERSONAL RADIATION DOSIMETER. (General Dynamics/Fort Worth, Tex.). Mar. 15, 1968. Contract NAS9-6287. 110p. (NASA-CR-92048; FZK-353). CFSTI.

Structural and operational details are provided on the personal radiation dosimeter (PRD) and the radiation survey meter (RSM) which were designed to monitor the radiation dose resulting from exposure to solar flares and the Van Allen radiation belt. The PRD has a 0- to 1000-rad range in 0.01-rad increments and measures cobalt-60 gamma fields of less than 60 rad/h to within ±10%, and fields greater than 60 rad/h to within 20% with a reproducibility of ±3%. It integrates incident radiation and displays the total dose on a five-digit register. The RSM has four selectable ranges: 0 to 100 mrad/h, 0 to 1 rad/h, 0 to 10 rad/h, and 0 to 100 rad/h. The survey meter measures cobalt-60 gamma dose rates to within ± 10% of full scale for each range with ±3% reproducibility. Radiation rate is measured on a linear meter readout. Various calibration and linearity tests of the instruments are described. Differences in response between the two devices are assessed. It is pointed out that range-energy tables indicate that the shield and outer electrodes of the detectors will absorb all electrons with energies less than approximately 0.55 MeV for normal incidence; this constitutes 45% of the P-32 beta spectrum on a particle basis. (auth) (STAR)

37994 (RD/B/N-1107) THE ASSESSMENT OF SKIN DOSE AND THE DEVELOPMENT OF THE SURVEY METER TYPE BP3. Playle, T. S.; Walker, W. N. (Central Electricity Generating Board, Bristol (England). Berkeley Nuclear Labs.). May 1968. 23p. Dep.

The criteria involved in the measurement of dose to the skin are reviewed, and the relevant characteristics of several types of radiation detectors which might be used in a portable survey meter for estimating this hazard are compared. A description is given of an instrument based on a shallow ionization chamber which was designed and built for this purpose; it incorporates a field effect transistor electrometer which provides a logarithmic response over the range 50 mRem hr^{-1} to 500 Rem hr^{-1}. (auth)

37995 (SC-TM-68-416) RESPONSE OF A THIN CRYSTAL NaI(Tl) SCINTILLATION PROBE TO ^{238}Pu X RAYS. Golden, J. C. Jr. (Sandia Corp., Albuquerque, N. Mex.). June 1968. Contract AT(29-1)-789. 7p. Dep. CFSTI.

This memorandum reports the results of an investigation into the response of a wound monitor to x rays from ^{238}Pu. The purpose of the wound monitor is to provide information for the guidance of medical personnel during treatment of potentially contaminated wounds. (auth)

37996 (UCID-15324) A TELESCOPE FOR EXAMINING THE VERTICAL INTENSITY OF COSMIC RAY FLUXES ON A WORLD-WIDE BASIS. MacGregor, G. A.; D'Arcy, R. G. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 8, 1968. Contract W-7405-eng-48. 15p. Dep. CFSTI.

The mechanical and electrical features of a fluorescer-photomultiplier cosmic ray telescope are described. The telescope has been used on frequent occasions to obtain cosmic ray equator points and to examine the vertical cosmic ray intensity at atmospheric depths of 200 to 250 g/cm^2. Statistical errors in the total counting rates were less than 1% and overall experimental errors totaled less than 2%. (auth)

37997 (UCLA-12-689) COMPARISON OF GAMMA RAY IMAGING DEVICES WITH A NEW THREE DIMENSIONAL PHANTOM. Hayes, Michael (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). June 10, 1968. Contract AT(04-1)-Gen-12. 9p. Dep. CFSTI.

A 3-dimensional phantom for providing information on imaging capacity for clinical use is described. It consists of either solid rods or hollow tubes of different diameters positioned diagonally in a plastic tank. With this phantom, imaging capacity can be determined for all depths from 0 to 7 in. by a single scan examination. Scans of the phantom using various radioisotope scanners are included. (W.H.K.)

37998 (UCRL-17989, pp 261-95) INSTRUMENTATION. (California Univ., Berkeley. Lawrence Radiation Lab.).

Instrumentation developments during 1967 are summarized. Discussed are differential circle dividers, time code generator, receiver for continuous day counting, germanium FET low-noise preamplifier, rapid x-ray fluorescence analysis of archaeological materials, improved liquid-ink pen assembly for CalComp digital plotter, computer control system for field-free spectrometer, modular 1- to 1.2-keV power supply, germanium detector system development, energy resolution of semiconductor detectors for 10- to 100-MeV particles, amplifier for gamma spectrometer, determination of ionization energy in semiconductor detectors, direct voltage calibration of iron-free beta spectrometer, and development of the 88-inch cyclotron. (W.H.K.)

37999 (UCRL-50437) Ge(Li) GAMMA-RAY SPECTROMETERS OF HIGH SENSITIVITY AND RESOLUTION FOR BIOLOGICAL AND ENVIRONMENTAL COUNTING. Phelps, Paul L.; Hamby, Keith O.; Shore, Bernard; Potter, Gilbert D. (California Univ., Livermore. Lawrence Radiation Lab.). May 24, 1968. 39p. Dep. CFSTI.

A high-resolution, anticoincidence-shielded, gamma-ray spectrometer was developed to analyze complex, low-level mixtures of gamma-emitting radionuclides in environmental and biological samples. The detector is a planar, lithium-drifted, germanium diode in combination with a sodium iodide crystal (15 cm × 20 cm), both of which are contained within a plastic annulus (76 cm × 76 cm). Two lithium-drifted, germanium detectors were evaluated: one of a large surface area (18 cm^2 × 1 cm active depth), and one of a smaller area (2.8 cm diam × 1.2 cm active depth). This configuration was found to significantly reduce the Compton background with a resultant marked enhancement of weak spectral lines. The sensitivity permits the detection of several radionuclides in environmental samples at levels below 0.05 pCi/g or 0.05 counts/min; e.g., 10 pCi of ^{137}Cs can be easily detected in 2 liters of cows milk. The spectrometer resolution of the 18-cm^3 Ge(Li) detector for a gamma energy of 1.17 MeV is 2.9 keV, full-width, half-maximum. Examples are presented of the spectral analysis of radionuclides in various biological and environmental samples contaminated with worldwide fallout, with debris from nuclear cratering experiments, or with reactor effluent. (auth)

38000 LIQUID SCINTILLATION AND GEIGER COUNTING EFFICIENCIES FOR ^{14}C INCORPORATED BY MARINE PHYTO-

PLANKTON IN PRODUCTIVITY MEASUREMENTS. Wolfe, Douglas A.; Schelske, Claire L. (Radiobiological Lab., Beaufort, N. C.). J. Cons. Perma. Int. Explor. Mer., 31: 31-7(Apr. 1967).

As an alternative to the use of a G–M counter, a method was developed for the measurement of absolute activities of ^{14}C-phytoplankton on filter papers directly by liquid scintillation counting of $^{14}CO_2$ recovered from combusted filters. This procedure permits a precise determination of G–M efficiency if the filter papers are counted with a G–M counter before combustion. The estimation of primary production of organic matter by marine phytoplankton by the ^{14}C method involves incubating phytoplankton for a known time in seawater containing $NaH^{14}CO_3$, filtering the plankton from the water, and subsequently determining the ^{14}C in the organisms on the filter paper. The efficiency of counting ^{14}C-phytoplankton on filter papers with a thin-window gas-flow G–M counter was 25.8% ± 1.19 (SD). Intact filter papers containing ^{14}C-phytoplankton were counted by liquid scintillation with an efficiency approximating that for soluble ^{14}C-toluene added as an internal standard. Liquid scintillation was shown to be a convenient and reliable substitute for G–M counting in productivity studies. (BBB)

38001 CORPUSCULAR PHOTOGRAPHY IN DEBRECEN. Medveczky, L. ATOMKI (At. Kut. Intez.) Kozlem., 10: 63-9 (Apr. 1968).

A short review of the work done at the Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI) as well as in the Institute for Experimental Physics of the Lajos Kossuth University in Debrecen and of the results achieved is given. (auth)

38002 TIME-TO-AMPLITUDE CONVERTER FOR MEASUREMENTS WITH NaI(Tl) SCINTILLATION DETECTORS ON THE LINEAR ACCELERATOR. Il'in, Yu. I.; Chirkin, V. A.; Savin, M. V. Prib. Tekh. Eksp., No. 2, 99-102(Mar.-Apr. 1968). (In Russian).

A circuit for a transistorized time-to-amplitude convertor, operating in a start–stop regime, was reported. The time resolution is not less than 2 nsec. The range of the measured time interval is up to 7 μ sec. The converter circuit makes possible time-of-flight measurements with NaI(Tl) scintillation detectors at an electron linear accelerator. (tr-auth)

38003 OPTICAL HETEROGENEITY OF INORGANIC SCINTILLATORS. Medvedev, M. N. (All-Union Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 2, 69-70(Mar.-Apr. 1968). (In Russian).

The results of the measurement of the optical heterogeneity of inorganic scintillators with NaI(Tl) and CsI(Tl) monocrystalline base were reported. It was shown that optical heterogeneity is inherent for each crystal. The numerical value of the heterogeneity is from 9 to 20% dependent on the dimensions and quality of the monocrystals. (tr-auth)

38004 EFFICIENCY OF THE REGISTRATION OF BETA-ACTIVE MATERIALS IN THE DISPERSED SYSTEM SCINTILLATION GRANULES–SOLUTION. Gel'fman, A. Ya.; Tsirlin, Yu. A.; Ekkerman, V. M.; Solomonov, V. M. (All-Union Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 2, 71-2(Mar.-Apr. 1968). (In Russian).

The possibility of using diffusion theory of the passage of light through light-scattering media for radiation measurements of β-active liquids was shown. Calculations were made of the dependence of the efficiency of registration on the thickness of the dispersed detector and experimental verification of the calculations was made. Good agreement with experiment made it possible, in particular, to use the proposed method of calculation for the explanation of the expediency of the use of samples of large volume in measurements with low β activities. (tr-auth)

38005 DETERMINATION OF THE CONCENTRATION OF FISSIONABLE MATERIALS IN SOLIDS. Abdullaev, Kh.; Kapustsik, A.; Otgonsuren, O.; Perelygin, V. P.; Chultem, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 73-5(Mar.-Apr. 1968). (In Russian).

A method for the determination of the concentration of fissionable materials with a precision up to ±10% in solids of known chemical composition was developed. The method is based on the use of dielectric detectors for charged particles: muskovite mica, silicate glass, lavsan, and polycarbonates. For each of these the dependence of the effective range of fragments on the atomic number of the medium studied was obtained. (tr-auth)

38006 MULTISECTION FISSION CHAMBER. Abil'daev, A. Kh.; Khodak, A. I.; Isabaev, E. A.; Yankovskii, A. V. (Inst. of Nuclear Physics, Ulugbek, USSR). Prib. Tekh. Eksp., No. 2, 76-7(Mar.-Apr. 1968). (In Russian).

In order to determine the content of fissioning elements and $^{238}/^{235}U$ isotopic ratios by registration of the fission fragments a 16-section fission chamber was constructed. The construction of the chamber guaranteed the registration of fragmented nucleus under high levels of interference in the horizontal channel of the VVR-S reactor. The sensitivity of the determination of U with the chamber described is 2×10^{-4}%. (tr-auth)

38007 MEASUREMENT OF THE PROBABILITY OF THE APPEARANCE OF AFTER PULSES IN SELF-QUENCHING COUNTERS. Dement'ev, V. A. (Agricultural Academy, Moscow). Prib. Tekh. Eksp., No. 2, 58-61(Mar.-Apr. 1968). (In Russian).

An installation for the measurement of the number of false operations (post-discharges) in self-quenching counters of nuclear radiation was described. An evaluation was made of the accuracy by which the probability of the appearance of after pulses can be measured. The results of the dependence of the appearance of false pulses on the counter voltage were reported. (tr-auth)

38008 THRESHOLD CHERENKOV COUNTERS WITH PLEXIGLAS RADIATORS. Petrukhin, V. I.; Pogosov, V. S.; Prokoshkin, Yu. D.; Simonov, Yu. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 61-5(Mar.-Apr. 1968). (In Russian).

The characteristics of the threshold Cherenkov counter with plexiglas radiator were investigated by means of a fast five-beam oscillograph on the beam of the JINR synchrocyclotron. (tr-auth)

38009 EQUIPMENT FOR THE REGISTRATION OF ALPHA PARTICLES IN REACTIONS CAUSED BY FAST NEUTRONS. Dolya, G. P.; Bozhko, V. P.; Tutubalin, A. I. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 2, 31-4(Mar.-Apr. 1968). (In Russian).

Experimental equipment for the registration of α particles from reactions of the (n,α) type was described. The ionization loss (dE/dx) was measured by two ionization counters filled with a mixture of 95% H_2 and 5% CH_4 at a pressure of 100 torr. The energies of the α particles were measured with scintillation counters, consisting of a FEU-13 with CsI(Tl) crystal. The use of the telescope of two proportional and scintillation counters in combination with an electron identification circuit made it possible to separate safely the α particles from the background of other charged particles in the energy interval from 3 to 25 MeV and to obtain their spectrum with energy resolution of ~10%. (tr-auth)

38010 SEMICONDUCTOR COUNTER TELESCOPE FOR DISCRIMINATION OF CHARGED PARTICLES. Andreev, M. F.; Zavgorodnii, V. A.; Serov, V. I.; Shchebiot, U. V.; Yurovskii, A. V. Prib. Tekh. Eksp., No. 2, 35-8(Mar.-Apr. 1968). (In Russian).

A method for the preparation of a $\Delta E-E$ counter telescope, providing for the discharge of the detectors under working conditions, was described. The telescope was intended for the discrimination of protons and deuterons from other charged particles in the energy interval from 5 to 15 MeV. A study was made of the characteristics of the individual counters and all systems in the chain. The thickness of the ΔE detector was 150 to 200 μ, the depth of the sensitivity range of the E detectors is 1.5 to 2 mm, and the working stage of the detectors is ~1 cm^2. The resolution capacity of the telescope at incident particle energies from 6 to 10 MeV is 90 to 130 keV for protons and 110 to 150 keV for deuterons. (tr-auth)

38011 BACKSCATTERING OF ALPHA PARTICLES FROM THICK METAL BACKINGS AS A FUNCTION OF ATOMIC WEIGHT. Hutchinson, J. M. R.; Nass, C. R.; Walker, D. H.; Mann, W. B. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 19: 517-22(June 1968).

Alpha-particle backscattering from various thick metal backings was studied using two separate counters with geometries of 2π and approximately 1π steradians. (auth)

38012 ABSOLUTE NEUTRAL OIL CONTENT OF VEGETABLE OILS BY RADIOCHEMICAL TECHNIQUE. Marcopoulos, C. A.; Manolkidis, K. A. (Greek Atomic Energy Commission, Athens). J. Amer. Oil Chem. Soc., 45: 67-9(Feb. 1968).

A radiochemical technique developed for determination of absolute neutral oil content is described and applied to a variety of Greek cottonseed oils. Also, the chromatographic refining loss was compared with the one determined by the radiochemical technique. The liquid scintillation counting method was chosen as the more convenient for the low β activities of ^{14}C. As liquid scintillator, a solution of 4 g of 2,5-biphenyloxazole and 0.2 g 2,2'-p-phenylenebis (5-phenyloxazole) benzene per l of toluene was used. Neutral triglycerides were labeled with ^{14}C-tripalmitin and passed through an alumina column to find out if the alumina retained a percentage of them. Cottonseed oil was also labeled and, by ap-

plying the calculations of the isotope dilution analysis, the absolute neutral oil content and therefore the theoretical refining loss were determined. The theoretical and the chromatographic refining losses were compared, and a relation between them is proposed for cottonseed oils. (BBB)

38013 EPITHERMAL NEUTRON SCINTILLATION DETECTOR. Gant, Orland J. Jr.; Gibson V, Benjamin F.; Pritchett, William C. (to Atlantic Richfield Co.). U. S. Patent 3,382,363. May 7, 1968. Filed Nov. 5, 1964.

A scintillation detector to be used in an epithermal neutron logging sonde is described. Thermal neutron shielding material is located around the periphery of the detector; neutron moderating material is contained within the center portion of the detector; and scintillation material is positioned between the shielding material and moderating material. The scintillation material can be formed as one or more cylindrical shells or as a plurality of rods. Where the scintillation material is formed as a plurality of units, the individual units are separated by beta-absorbing material. (U. S. Pat. Gazette)

38014 RADIATION DETECTOR MADE FROM TITANIUM OR ZIRCONIUM. Chameroy, Jean Gustave; Wilmart, Yves (to Societe Anonyme: Groupement Atomique Alsacienne Atlantique). U. S. Patent 3,382,390. May 7, 1968. Priority date Jan. 15, 1964, France.

An ionization chamber made of titanium or zirconium for use at high temperature is described. Boron or boron trifluoride is employed for detecting neutrons. (W.H.K.)

38015 HIGH-SPEED, HIGH SENSITIVITY, IONIZING RADIATION DETECTOR. Locker, R. J.; Huth, G. C. (to United States Atomic Energy Commission). U. S. Patent 3,392,315. July 16, 1968.

A radiation detector having a semiconductor for producing electrical signals corresponding to the energy of incident radiation, and a small, compact, low power tunnel diode for amplifying the signals is described. The portable detector can be used for the detection of low energy radiation. (AEC)

38016 METHOD FOR PREPARATION AND ENCAPSULATION OF GERMANIUM GAMMA RAY DETECTORS. Fox, R. J. (to United States Atomic Energy Commission). U. S. Patent 3,390,449. July 2, 1968.

A method for preparing and encapsulating lithium-drifted germanium gamma ray detectors so that there is no loss of lithium by out-diffusion and so the detector will remain stable through a relatively long lifetime is described. A conventionally prepared germanium crystal detector having a lithium-doped surface is etched and then coated with a deposit of metallic lithium over the lithium-doped surface before being hermetically sealed in a suitable container under high vacuum and immersed in liquid nitrogen. (AEC)

38017 STABILITY OF SCINTILLATION RADIATION DETECTORS. Boucek, J. (Charles Univ., Prague). Sb. Lek., 70: 56-9(1968). (In Czech).

The lack of stability of different components of a single-channel scintillation counter affects the accuracy of measurements made with such an instrument in medical radioisotope diagnostic work. The main source of instability is the photomultiplier. Changes in the amplification of the photomultiplier depend on its anode current. For physical measurements various stabilizers of the spectrum are used which contain automatic equipment that maintains the current of the anode of the photomultiplier at a constant level. This equipment is complex, and in nuclear medicine this method of stabilization cannot be used. It is therefore important to assess the stability of the scintillation detector and to assess the optimum working conditions. Measurements were made to investigate the influence of different radiation levels on the stability of a photomultiplier manufactured in Czechoslovakia. It was not feasible to stabilize the parameters of the photomultiplier by higher activities than those which are encountered in routine measurements. For detection of the photopeak a satisfactory reproducibility of scintillation detectors with photomultipliers manufactured in Czechoslovakia was found in the 10-μCi region for ^{137}Cs. (BBB)

38018 DISCHARGE MECHANISM IN GASES IN THE SUBNANOSECOND REGION. D'Alessio, Juan T.; Lanza, Hilda (Comision National de Energia Atomica, Buenos Aires). Rev. Sci. Instrum., 39: 1029-35(July 1968).

The mechanisms of spark generation which produce luminous and electric pulses of the order of subnanoseconds in a gas at a high pressure are analyzed. The classical mechanisms, which account for regenerative processes initiated by the photons produced during the avalanches of electrons, cannot explain the generation of 10^{11} electrons in 0.3 nsec, which were experimentally detected when using our generator. In this work, the experimental results are interpreted by means of a model which considers the equilibrium surface shape of the liquid as the resultant of an increase in the field near the electrodes up to $10^{9}-10^{10}$ V/cm (the surface shape is determined by the superimposed effect of the electric field and the surface tension). With a field of this magnitude, electrons are produced at the cathode in numbers large enough to explain the experimental results. In agreement with the model proposed, pulses of 10^{-10} sec duration can only be obtained with liquid electrodes in gases at a high pressure. (auth)

38019 RAPID METHOD OF TRACING CHARGED PARTICLE BEAMS. Arnold, H.; Hoekstra, R.; Wieringa, W. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Rev. Sci. Instrum., 39: 1069(July 1968).

It is shown how dry developing paper can be useful in tracing charged particle beams. Gavaert Oscilloscript D paper which does not need wet developing and fixing procedures was irradiated in air. The results are immediately available after exposure to the beam. The paper is insensitive to artificial light unless it is previously irradiated with uv light by charged particles. The development of the irradiated parts takes about 15 sec by exposing it to the light of a mercury or a tungsten lamp. (B.G.D.)

38020 METHOD OF STRETCHING POLYPROPYLENE FOR USE AS SOFT X-RAY DETECTOR WINDOWS. Caruso, A. J.; Kim, H. H. (National Aeronautics and Space Administration, Cambridge, Mass.). Rev. Sci. Instrum., 39: 1059-60(July 1968).

Gas-filled ionization chambers for soft and ultrasoft x rays require windows which are transparent in this spectral region and can support the difference between the pressure of the filling gas and the evacuated environment of the detector. It is shown that polypropylene, properly prepared, is a window material far superior to any available. The preparation and evaluation of polypropylene as a soft x-ray detector window material are discussed. (B.G.D.)

38021 MULTI-PLATE IONIZATION CHAMBER WITH GAMMA-COMPENSATION AND GUARD-RING ELECTRODES. Hyun, Kyung Ho (to English Electric Co., Ltd.). U. S. Patent 3,385,988. May 28, 1968. Priority date Aug. 23, 1963, Great Britain.

The ionization chamber is composed of an enclosed vessel, a plurality of polarizing plate electrodes arranged parallel to and alternately with a plurality of collector plate electrodes connected electrically, a neutron-sensitive coating on one of each collector plate electrodes, and an ionizable gas in the vessel. Also, means for connecting the polarizing plate electrodes to a voltage source and means for collecting from the collector plate electrodes a current caused to flow in response to the intensity of nuclear radiation are described. A co-planar electrically-conducting peripheral plate member encircling each collector plate electrode and insulation between each said peripheral plate member and the corresponding collector plate electrode are included. (U. S. Pat. Gazette)

38022 LOW ENERGY COSMIC X-RAY PROPORTIONAL COUNTER SYSTEM. Cornell, C. M.; Grader, R. J.; Harri, J. G.; Hill, R. W.; Rumble, R. P.; Salmi, D. S. (Univ. of California, Livermore). Rev. Sci. Instrum., 39: 951-7(July 1968). (UCRL-70836).

A rocket-borne, thin window proportional counter system has been developed and used for several x-ray astronomy experiments in the range from 200 eV to 10 keV. The counter energy spread has been measured as 17% at 6 keV and varies approximately with the square root of the energy. The counter construction, gas system and pulse height preserving electronics are described. (auth)

38023 APPLICABILITY OF A LARGE VOLUME LIQUID SCINTILLATION COUNTER TO COINCIDENCE COUNTING TECHNIQUES. Grunewald, Ralph. Lafayette, Ind., Purdue Univ., 1965. 103p.

Thesis.

The operating characteristics of a large volume liquid scintillation counter, Sinco-P, were studied when operated in the 4 pi sum peak and 4 pi coincidence modes. High energy muons pass through the steel shield and both detector tanks, depositing about 82 MeV in the detector tanks. There were about 20,000 cpm due to pulses whose energy was greater than 3 MeV. Of these, about 12,000 cpm were in coincidence. Spectra of various nuclides were obtained in the 4 pi sum peak and 4 pi sum peak coincidence modes. The mono gamma emitters studied were Cr-51, Cs-137, Rb-86, and K-40. The positron emitters Co-58 and Na-22 and the cascade gamma emitters Na-24 and Co-60 were studied. For point sources, scatter from one tank to another was observed, with a maximum Compton interaction in each tank. The background count rate was considerably reduced when Sinco-P was used in coincidence modes. In the 4 pi sum peak coincidence mode, the background in the Na-22 positron annihilation gamma channel was about 1,300 cpm or 5.88% of the background in the 4 pi sum peak mode. In the 4 pi coincidence mode, the background in the Na-22 positron annihilation

gamma channel was about 260 cpm or 1.16% of the background in the 4 pi mode. In the coincidence modes there was excellent discrimination against mono gamma emitters, e.g., in the 4 pi sum peak coincidence mode, CS-137 counted less than 1% in the Na-22 positron annihilation gamma channel while the Na-22 counted about 18.4%. The relative response of Sinco-P was about the same for both the 4 pi sum peak coincidence and 4 pi coincidence modes. Comparisons were made for background depression, position versus efficiency, weight versus efficiency, and activity versus counts obtained. The efficiency in the coincidence modes dropped off sharply as the sample approached either end of the sample chamber. In the 4 pi sum peak coincidence mode the background depression in the Na-22 channel was 0.0009211 cpm/lb/cpm background, and for the 4 pi coincidence mode was 0.0008774 cpm/lb/cpm background. A dual tag experiment involving Na-22 and K-42, using a combination of coincidence and anticoincidence modes, was suggested. By use of more sophisticated electronics an improvement in efficiency would be expected. The results suggest that the capability and uniqueness of Sinco-P could be expanded by having available a combination of "normal" (accepting all pulses); coincidence and anticoincidence modes. (Diss. Abstr.)

38024 RADIO- AND THERMO-LUMINESCENCE DETECTION AND MEASUREMENT OF TRITIUM IN THIN-LAYER RADIOCHROMATOGRAPHY. Prydz, Svein; Petersen, Christian; Koren, Jan F. (Univ. of Oslo). Phys. Norv., 2: 343-50(1967).

Experimental studies are reported on the feasibility of basing tritium detection and measurement in radiochromatography on the use of sensitive β-to-light converters (cathodoluminophors) combined with photomultiplier of high-speed photographic film. This method is more sensitive than that of particle counting and that of direct exposure of x-ray film to the β particles. For various standard thin-layer preparations the relative scintillation efficiencies have been studied at ordinary and low temperatures. It is found that small amounts of Mn-doped zinc-silicate added extraneously (as an uv indicator) greatly enhance the scintillation yield. Discussed also is the alternative or additional admixture of anthracene as a scintillator. Photomultiplier evaluation of tritium activities in dry preparations containing a solid scintillator appears to offer advantages over other detection methods. (auth)

38025 USE OF APPROXIMATE QUADRATURE FORMULAS FOR THE FAST NEUTRON FLUX EVALUATION BY THRESHOLD DETECTORS. Marseguerra, Marzio; Menaplace, Enzo; Motta, Mario (CNEN, Bologna). Nukleonik, 11: 108-10(May 1968).

A new method of analysis of threshold detector data, in which use is made of approximate quadrature formulas to unfold the neutron spectrum, is given. The activation rates are analyzed one at a time and approximate values of the flux at discrete energy points are quickly obtained. Examples of the application of this method are given. (auth)

38026 ELECTRONICS ASSOCIATED WITH LARGE VOLUME LIQUID SCINTILLATION DETECTORS. Craig, Edwin Charles. Lafayette, Ind., Purdue Univ., 1966. 121p.

Thesis.

It is known that muons passing through a large volume liquid scintillation detector deposit more than 4 MeV/in. As a result of these interactions, pulses with large amplitudes should be present at the outputs of the photomultiplier tubes. The background pulses at the outputs of the photomultiplier tubes on the large volume liquid scintillation detector at Purdue University, Sinco-P, were measured with an oscilloscope and found to have amplitudes up to 25 V. However, most of the pulses had amplitudes of 5 V or less. It was desired to test the ability of transistorized preamplifiers to process pulses with these amplitudes without suffering damage or a change in characteristics. A pulse generator was used to subject a transistorized preamplifier to pulses with these amplitudes over extended periods of time. It was found that the best setup of transistorized equipment for counting ^{137}Cs and ^{40}K simultaneously in the 4π sum peak mode consisted of a mixer-preamplifier, one linear amplifier, two single channel analyzers and two scalers. A comparison of the performances of the vacuum tube equipment used with Sinco-P at that time and the transistorized setup was made at three different levels of activity. Comparisons of the performances of the two types of equipment when counting positron emitters in the coincidence modes were also made. The coincidence loss at high count-rates was found to be greater for the vacuum tube equipment than for the transistorized equipment. A negative peak shift was found at high count-rates. This was more pronounced for the vacuum tube equipment than for the transistorized equipment. The efficiency of the transistorized equipment was found to be higher than that of the vacuum tube equipment at both intermediate and low levels of sample activity. In counting positron emitters in the coincidence modes the efficiency of the transistorized equipment was much greater than that of the vacuum tube equipment. A significant negative correlation was found between background count-rate and atmospheric pressure. No significant correlation was found between background count-rate and room temperature, room humidity, or radon decay products in the atmosphere. (TSS) (Disser. Abstr.)

38027 MATERIAL REQUIREMENTS FOR SEMICONDUCTOR DEVICES USED IN GAMMA RAY DETECTION. Mayer, J. W. (Hughes Research Labs., Malibu, Calif.). pp 1-10 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The requirements are presented for a high Z semiconductor nuclear particle detector suitable for operation as a gamma detector at elevated temperatures. Fully depleted devices of thickness greater than 2 mm with non-injecting contacts require highly compensated material with $|N_D - N_A| < 5 \times 10^{11}/cm^3$. Trapping processes will have the dominant effect on detector performance. Analytic expressions are given for the transient response for different values of the trapping and detrapping times. The influence of detrapping is to introduce a slow component in the response that results in strongly temperature dependent pulse height distributions. By compromising detector performance but still permitting good gamma detection characteristics, it is possible to establish material criteria that are within the reach of present technology. (auth)

38028 GLASS NEUTRON TRACK DETECTOR. Obaturov, G. M.; Chumbarov, Yu. K.; Fedotova, L. N. At. Energ. (USSR), 24: 479-81(May 1968). (In Russian).

A simple and rapid method was developed for determining the neutron flux by the intensity of scattered light from a dull glass surface. The surface of glass irradiated by fission fragments becomes matted after being treated in HF solution. The dullness of the glass depends on the number of depressions caused by fission fragments and from neutron irradiation of the glass with a layer of fission fragment. Experiments used a photoplate glass (usually used in nuclear studies) in contact with ^{235}U 95% enriched 12 mg/cm^2-thick layers. The layers consisted of U_3O_8 and were coated by a ~0.1 mg/cm^2 thick cellulose coating. The glass was irradiated by slow neutrons from Po–Be source at 20°C temperature. The number of tracks per cm^2 as a function of the thermal neutron flux was investigated in the range from 5×10^6 to 2×10^8 neutrons/cm^2. The irradiated glass was treated in a 10% HF solution. The sensitivity of track detectors was ~1.0×10^{-4} track/neutrons with the order of error ±3%. A microscopic method of detecting made it possible to measure integral neutron flux tracks from 3×10^4 to 2×10^8 neutrons/cm^2. (R.V.J.)

38029 FAST/THERMAL NEUTRON RATIOS DETERMINED BY Ge(Li) GAMMA SPECTROMETRY. Nelson, J. B. (Texas Nuclear Corp., Austin, Tex.); Blake, K. R.; Mitchell, J. C.; Allen, S. J.; Hurt, W. D. pp 334-40 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Fast to thermal neutron ratios are often determined by measurement of the cadmium in/out gamma ratio using the $^{197}Au(n,\gamma)$ reaction. However, the $^{197}Au(n,2n)$ reaction competes strongly in the presence of 14-MeV neutrons and limits the usefulness of gold foil when counted in a NaI gamma-ray spectrometer. A method utilizing a high resolution Ge(Li) spectrometer whereby the fast and thermal neutron fluence can be measured using gold foil only is described. (auth)

38030 USE OF SEMI-INSULATING CdTe AND GaAs FOR GAMMA DETECTION. Zanio, K.; Akutagawa, W.; Mayer, J. W. (Hughes Research Labs., Malibu, Calif.). pp 140-5 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Both CdTe and GaAs are promising materials for gamma detection at elevated temperatures because of their wide bandgaps, 1.45 eV, and high effective Z. Semi-insulating CdTe (Z = 50) has shown a photopeak when irradiated by 393 keV gammas under conditions where heavy trapping predominates. By analyzing the transient response of semi-insulating materials to 6.04 and 8.78 MeV alpha particles the transport properties of carriers have been measured. The response consists of an initial fast component and an additional slow component whose rise times differ by an order of 10^3. The fast component is proportional to $[1 - \exp(-t/\tau^+)]$ where τ^+ is the carrier mean free drift time or trapping time. From the shape of this component τ^+ and mobilities

for electrons have been measured. Electron mobilities range from 600 to 1100 $cm^2/V\text{-}sec$; τ^+ from 30 to 90 ns. The slow component of the pulse represents the release of carriers from traps and their subsequent displacement. Heating affects the pulse shape of the slow component but the fast component is nearly independent of temperature. For the slow component faster rise times are found upon heating at temperatures up to 110°C in both CdTe and GaAs. Detection of gammas through either the fast component or total pulse is possible, the choice depending upon optimizing the signal to noise ratio. (auth)

38031 HIGH-TEMPERATURE PERFORMANCE OF AN AVALANCHE RADIATION DETECTOR. Johnston, P. A.; Locker, R. J.; Trice, J. B.; Huth, G. C. (General Electric Co., Philadelphia). pp 146-51 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Results of gamma-sensitivity measurements made on four contoured avalanche detector-tunnel diode instruments are presented over a temperature range extending from 30°C to 100°C. The counting efficiency of these instruments remained relatively constant over the temperature range investigated when the bias voltage supplies of the contoured avalanche detector and the tunnel diode were adjusted accordingly. In addition, leakage currents in excess of 100 microamps were found to severely reduce unit sensitivity above 100°C. However, it is believed that by reducing the room temperature leakage currents of the detector to values similar to those observed for small signal devices that high temperature operation may approach 200°C. These observations as well as typical temperature compensation techniques for the instrument power supplies are discussed. (auth)

38032 RECENT ADVANCES WITH CONTOURED DETECTORS. Trice, James B. (General Electric Co., Philadelphia). pp 152-9 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Recent developments in silicon contoured detectors have shown their properties to be of use in several diverse applications, such as infrared laser ranging and communication, high-temperature radioisotope fuel gaging, and low-energy x-ray detection. Recent research and development that serves as the basis for exploitation of these applications is reviewed. Infrared detection and high-speed electronics are discussed along with comparative measurements against state-of-the-art detectors, such as an S-1 photomultiplier and a nonmultiplying silicon detector. Advantage factors of sensitivity at 9000 Å in excess of an order of magnitude are obtained. The development of a detection device for gamma radiation to operate in excess of 100°C is briefly described along with problems that have to do with extension of the temperature range. Finally, the ability of thin-window contoured detectors to measure low-energy x-ray spectra between 1 and 10 kilovolts is presented within the framework of a series of measurements in which the detectors were irradiated by monoenergetic x-rays. (auth)

38033 SILICON P–N JUNCTION DETECTORS FOR HIGH-TEMPERATURE OPERATION. Harvey, N. P.; Bernou, J. P. (Simtec Ltd., Montreal). pp 160-5 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The range of temperatures over which silicon detectors are reliably operable has been extended by consolidation and improvement of the bandguard type structure. Process and experimental details are given for construction and testing of high-reliability detectors capable of counting 500 keV particles or 1 MeV γ-rays at 120°C. Results are presented for a test group taken from several standard production runs together with indications of 28% production yield (devices suitable for high temperature operation). (auth)

38034 CHARACTERIZATION OF GERMANIUM AND SILICON FOR NUCLEAR RADIATION DETECTORS. Bullis, W. M.; Coleman, J. A. (National Bureau of Standards, Washington, D. C.). pp 166-75 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Uncontrolled variations in the quality of germanium and silicon for radiation detection have occurred for reasons which are not well understood. Crystals are presently selected on the basis of room temperature resistivity, photoconductive decay lifetime and etch pit density. Use of these parameters does not always enable one to discriminate between material suitable for detector fabrication and material which is not. A research program now in progress at the National Bureau of Standards which has the objective of identifying those parameters which will be the most useful in specifying detector-grade material is described. Because of the immediacy of the problem, study of germanium suitable for lithium-compensated detectors is being emphasized. Some of the results of this program should also be applicable in the characterization of detector-grade silicon. (auth)

38035 CONTROL OF LITHIUM MIGRATION AND PRECIPITATION IN GERMANIUM SINGLE CRYSTALS. pp 176-81 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Lithium mobility alone is not a sufficient criterion to characterize germanium single crystals for suitability in making radiation detectors. The second important property concerns lithium precipitation rate. A method for lithium drifting is described which allows the extraction of meaningful lithium precipitation data. (auth)

38036 GaAs AND GaP FOR ROOM TEMPERATURE GAMMA-RAY COUNTERS. Weisberg, L. R.; Goldstein, B. (RCA Labs., Princeton, N. J.). pp 182-6 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Today, only silicon is suitable for a gamma-ray counter operating at or near room temperature. Although many other semiconductors can be prepared in a semi-insulating state for room temperature conduction counters, they are unsuitable because of excessive trapping. The GaAs–GaP system has some inherently superior properties to silicon, including higher atomic number, higher resistivity, and higher mobility. This permits the presence in the GaAs–GaP system of a much larger trap density, ($\sim 10^{15}$ cm^{-3}) without necessarily degrading the collection efficiency. By the use of vapor phase growth, recent advances have been made in the state-of-the-art of preparing GaAs–GaP materials. At RCA Laboratories, these materials have been vapor-phase grown with sufficiently high growth rates, with low trap densities ($\sim 10^{14}$ cm^{-3}), good homogeneity, with excellent contacts, and in a semi-insulating state. This places the GaAs–GaP system ahead of other compound semiconductors, and indicates that detectors should be able to be fabricated with properties comparable to gold-doped silicon detectors, except at room temperature rather than near 100°K. Previously reported experiments in these materials showed that a high counting efficiency can be achieved. (auth)

38037 DISCRIMINATOR FOR FAST SCINTILLATION COUNTER PULSES WITH MINIMAL TIME JITTER. Murn, R. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia). Nucl. Instrum. Methods, 63: 233-4(Aug. 1968).

A fast discriminator with minimal time jitter is described. The discriminator consists of two conventional amplitude tunnel diode discriminators and can be used also with not extremely fast tunnel diodes. (auth)

38038 ANTHRACENE CELL FOR COUNTING WEAK-BETA-EMITTING NUCLIDES (^{35}S) IN LIQUID SAMPLES. Albert, S. N.; Zekas, E.; Timby, R. MacK. (Washington Hospital Center, D. C.). Contract AT(30-1)-3687. J. Nucl. Med., 8: 822-8(Nov. 1967).

A zig-zag unidirectional channel is milled in the surface of a Lucite disc and scintillation-grade anthracene crystals are packed in the channel. Another Lucite disc is glued over the prepared disc, and a photomultiplier tube is placed adjacent the Lucite. The liquid sample flows through the channel for beta counting. Calibration and performance of the cell are discussed. (W.H.K.)

38039 LINE-SOURCE PHANTOM FOR TESTING THE PERFORMANCE OF SCINTILLATION CAMERAS. Jahns, Eberhard (Univ., Heidelberg); Hine, Gerald J. J. Nucl. Med., 8: 829-36 (Nov. 1967).

A line-source phantom is described with which the principal characteristics of a scintillation camera can be verified in a short time. The uniformity of camera performance, its spatial resolution and its depth response may be checked for either a single or several γ-ray energies. Scintiphotos obtained with a Nuclear-Chicago Pho/Gamma scintillation camera are presented. The phantom may be used for routine checking of any camera system as well as for determining the best operating conditions for a particular clinical problem. (auth)

38040 TOTAL ABSORPTION NUCLEAR CASCADE DETECTORS FOR HIGH ENERGY PHYSICS. Hofstadter, R. (Stanford Univ., Calif.). Contract Nonr-225(67). Nucl. Instrum. Methods, 63: 136-40(Aug. 1968).

A new type of detector (TANC counter) of high energy particles

is proposed which operates on the principle of total absorption of all nuclear cascade products of the impinging particle. This detector will be sensitive to neutral particles (including gamma rays) as well as charged particles and will have 100% efficiency for detection. The counter can have high speed, good energy resolution, discrimination properties, large dynamic range and virtually no limit to the highest energy detectable. Some preliminary experimental results are shown which indicate that the counter will operate as expected. (auth)

38041 USE OF COLLIMATED GAMMA-RAY BEAMS IN THE STUDY OF Ge(Li) DETECTORS. Webb, P. P. (RCA Victor Co. Ltd., Montreal); Malm, H. L.; Chartrand, M. G.; Green, R. M.; Sakai, E.; Fowler, I. L. Nucl. Instrum. Methods, 63: 125-35 (Aug. 1968).

Useful studies of Ge(Li) detectors can be made with well-collimated beams of γ-rays. Choice of γ-ray energy (0.3 to 1 MeV) and design of collimators are discussed. Eight examples of the use of this technique are given: measurements of the undrifted core in coaxial detectors; locating the position of the sensitive volume and measuring detector efficiency; locating positions of poor resolution; determination of carrier trapping; study of carrier transit times; study of timing characteristics; determination of $\mu\tau$ for the trapped carrier and estimation of trapping lifetime; study of the origin of slow rising pulses. (auth)

38042 USE OF ION IMPLANTATION TECHNIQUES TO FABRICATE SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Mayer, J. W. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods, 63: 141-51(Aug 1968).

This is a review of ion-implantation processes as applied to semiconductor nuclear particle detectors. The role of channeling effects in determining the distribution of implanted atoms, defects and junction characteristics is discussed. A simple method for aligning crystals "in situ" is presented. A summary is given of the anneal characteristics of lattice disorder, lattice site location of implanted atoms, and the electrical characteristic of the implanted layer. Results are presented of ion-implanted particle detector performance. (auth)

38043 MEASUREMENT OF SMALL REACTIVITIES BY THE DIRECT REACTIVITY METER METHOD. Dierckx, R.; Hage, W.; van Mauwe, A. (EURATOM-CCR, Ispra, Italy). Nucl. Instrum. Methods, 63: 166-72(Aug. 1968).

The use of a direct analog reactivity meter was studied for the measurements of small reactivities down to 0.01 p cm. The difference between the stable reactor flux and the instantaneous flux is processed in a specially designed reactivity meter producing an output which is the causal reactivity change as a function of time. With a simplified reactor model an error analysis was made, and test measurements executed on the EC0 reactor. (auth)

38044 HIGH EFFICIENCY GRAPHITE-MODERATED NEUTRON COUNTER. Jewell, R. W.; John, W.; White, D. H. (Univ. of California, Livermore). Nucl. Instrum. Methods, 63: 185-8 (Aug. 1968).

A high-efficiency neutron counter has been built, consisting of 40 1.5-m $^{10}BF_3$ proportional counters imbedded in a graphite cylinder 1.83 m long and 1.53 m in dia. The system is surrounded by 0.6 m of water on all sides to act as a reflector and shield, and is operated with the neutron sources placed at the center. The basic design was dictated by the requirements for an energy independent, high neutron efficiency for weak neutron sources in the presence of high γ-ray activity. This ruled out moderators having a high neutron absorption cross section or low photoneutron threshold. The configuration design was based upon diffusion studies and extensive Monte-Carlo calculations. The resulting configuration consisted of a hexagonal matrix of individual counters forming five rings parallel to the cylindrical axis. The measured total efficiency was found to be about 60% and nearly independent of energy, although the relative efficiency among rings was energy dependent. (auth)

38045 APPLICATION OF SOLID-STATE TRACK DETECTORS FOR MEASURING ANGULAR DISTRIBUTIONS OF ALPHA-PARTICLE GROUPS FROM NUCLEAR REACTIONS. Somogyi, G.; Schlenk, B.; Varnagy, M.; Mesko, L.; Valek, A. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instrum. Methods, 63: 189-94(Aug. 1968).

For α-particle tracks in cellulose nitrate and cellulose acetate detectors there is a correlation between the diameters of the track holes and the particle energies. On this basis there is a possibility to distinguish α-groups of different energy produced by nuclear reactions and to measure their angular distributions. The usefulness of the cellulose acetate (T-cellit) track detectors was investigated for determining angular distributions of α_0, α_1, α_2, and α_3 groups from the reaction $^{19}F(d,\alpha)^{17}O$. To check the results obtained by solid-state track detector the angular distributions were determined also by using a semiconductor detector. The relative angular distributions measured by these two different methods after normalizing were in good agreement with each other within the limit of the statistical accuracy. It is concluded that the cellulose acetate track detectors can be used successfully for studying the angular distributions of α-particles from nuclear reactions. (auth)

38046 CHARGE IDENTIFICATION OF STOPPING PARTICLES IN NUCLEAR EMULSIONS. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). Nucl. Instrum. Methods, 63: 201-4(Aug. 1968).

Track-width measurements have been made on 66 suitable tracks of known charges in L4 emulsions. It is found that for charge identification fine grain emulsions are better suited and in such emulsions a high level of confidence (≈90%) is obtained in charge resolution if the width of the solid core of the tracks is measured instead of the full width. An empirical relation between the width and the dip angle of tracks has been obtained. The track-width is found to vary linearly with charge. (auth)

38047 WIDTH OF HEAVY-ION TRACKS IN EMULSION. Kobetich, E. J.; Katz, Robert (Univ. of Nebraska, Lincoln). Phys. Rev., 170: 405-11(June 10, 1968).

Profiles of the solid core of long, flat, ending tracks of heavy primary cosmic rays in Ilford G-5 emulsion have been measured by manually tracing their enlarged (3500×) photographic image. These measurements agree well in the ending 3000 μ of residual range ($\beta < 0.3$) with a reformulated theory of track width based on computation of the spatial distribution of ionization energy. The measured core width in G-5 emulsion is the sum of the sensitized cylinder diameter, at which 6000 erg/cm^3 of ionization energy is deposited by δ rays, and the diameter of a developed grain. (auth)

38048 ON THE USE OF A PENNING TUBE TO DETECT CHARGED PARTICLES AND GAMMA RAYS. Bobykin, B. V.; Kel'man, V. M.; Nazarenko, L. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 38: 194-9(Jan. 1968). (In Russian).

The ignition and photon-counting characteristics of a cold cathode low pressure Penning tube comprising a 1.6 cm diameter 1.8 cm long polished brass cylindrical anode and two 2 cm diameter plane cathodes mounted in an axial magnetic field with 1.5 mm gaps between the cathodes and the cylindrical anode are studied. The investigation was undertaken because of the possible advantages of a Penning tube as a charged particle detector, stemming from the fact that the Penning tube will operate at very low gas pressures and can therefore frequently be mounted directly in the vacuum system with no window separating the counter from the source of particles. The minimum magnetic field strength for which discharge took place (ignition field) with an 8 μC ^{60}Co gamma ray source mounted 5 cm from the center of the Penning cell was determined for different anode potentials from 0.6 to 2.0 kV and different gas (air) pressures from 5×10^{-6} to 10^{-4} mm Hg. The ignition field increased gradually and smoothly with increasing anode potential except for a discontinuous drop of about 10% at a certain anode potential that depended on the gas pressure. Measurements of the ignition field in the absence of the ^{60}Co source were not reproducible. Pulses initiated by gamma rays from the ^{60}Co source were counted with an anode potential of 800 V, a gas pressure of 10^{-4} mm Hg, and a magnetic field strength of 350 Oe. The tube was automatically quenched 40 times per second by briefly removing the anode potential. The inverse square law was verified for distances between the ^{60}Co source and the discharge chamber ranging from about 10 cm (counting rate, about 830 per hour) to 50 cm. The background in the absence of the ^{60}Co source was about 1 pulse per hour. It is suggested that the Penning tube would count charged particles more efficiently than it counts photons. (ATD)

38049 COMPARISON OF MODELS OF ELECTRON LIBERATION AND PASSAGE THROUGH MATTER USED IN CALCULATING ABSORBED DOSE NEAR AN IRRADIATED INTERFACE. Charlton, D. E. (Sir George William Univ., Montreal); Cormack, D. V. pp 413-31 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

Empirical models of electron liberation and penetration through matter which have been used to calculate dose distributions near interfaces in irradiated media are discussed. The influence (geometrical) functions evaluated from the models as well as those developed from a new model in which a distribution of electron ranges is incorporated is discussed. The distribution of ranges in this multiple-range model was chosen by calculating dose distributions near a point isotropic source of monoenergetic

electrons using various range distributions. Measurements of the energy absorbed in an aluminum-walled ionization chamber filled with hydrogen, air, or argon irradiated by 100-keV x-rays compared with those made using an exposure-calibrated cavity ionization chamber are reported. Measurements made at various plate separations and gas pressures are compared with data calculated from constant and varying LET models. (auth)

38050 RELATION BETWEEN ENERGY ABSORPTION AND IONIZATION IN TISSUE EQUIVALENT GAS FOR GAMMA QUANTS OF LOW ENERGY. Booz, J. (EURATOM, Ispra, Italy). pp 331-51 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The pulse height distributions of characteristic x-rays of light elements are measured with a proportional counter that is filled with tissue equivalent gas (64.4% CH_4; 32.4% CO_2; 3.2% N_2). They are compared with the pulse height distributions of single electrons of zero energy that are measured simultaneously. The mean pulse height of the single electron spectra which corresponds to 1 electron is used to calibrate the x-ray spectra in number of ion pairs. Thus accurate values of W (average energy per ion pair) are evaluated. (auth)

38051 APPLICATION OF JAFFE AND LEA THEORIES OF RECOMBINATION TO THE DETERMINATION OF LET AND QF WITH IONIZATION CHAMBERS. Dennis, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 313-29 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The application of the Jaffe theory of columnar recombination and the Lea theory of cluster recombination to tissue-equivalent ionization chambers is considered. It is shown that the theory predicts the experimentally observed constancy of d(log i)/d(log V) with applied voltage when the LET of the radiation is sufficiently low, but indicates that this constancy will not hold for very high LET values. It is shown that over a practical range of LET values that d(log i)/d(log V) will be proportional to the QF values, but will give added weight to the higher LET values when measuring mixed radiations. (auth)

38052 PATH LENGTH DISTRIBUTIONS WITHIN CYLINDERS OF VARIOUS PROPORTIONS. Wilson, K. S. J.; Emery, E. W. (Hammersmith Hospital, London). pp 79-92 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

Calculations of path length distributions are presented for cylinders of various height/diameter ratios in an isotropic distribution of straight tracks. These distributions were calculated for application to cylindrical proportional counters for microdosimetry. (auth)

38053 DEVELOPMENT OF A CHROMOSOME COUNTER. Booz, J.; Smit, Th. (EURATOM, Ispra, Italy). pp 125-45 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

A new type of counter for the measurement of the energy absorption spectrum is presented in which the functions detection and multiplication of a normal proportional counter are kept separated. The detector is a cylindrical tube which is exposed to the radiation. It is attached to the shielded multiplier which is a large cylinder with an internal diameter of 30 cm in which the electron avalanche takes place. Inside the detector there is a negative potential in relation to the multiplier wall. Thus the electrons that are produced in the tissue equivalent gas in the detector can drift along the lines of electric force into the multiplier where they are measured. The counter has been tested at various gas pressures which correspond to a detector diameter between 50 Å and 1000 Å. Experiments and calculations on the diffusion loss of single electrons drifting from different points of the detector to the multiplier are presented and discussed. (auth)

38054 SOME MEASUREMENTS WITH A ROSSI TISSUE EQUIVALENT PROPORTIONAL COUNTER. Field, S. B.; Wilson, K. (Hammersmith Hospital, London). pp 147-60 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

A proportional counter with the same chemical composition as soft tissue has been developed by Rossi. It can record ionizing events in spherical elements of simulated tissue with diameters of less than 1 micron. The instrument has been used to compare distribution of energy loss from a collimated alpha particle source with the theory, and to measure the LET spectrum of the Hammersmith cyclotron fast neutron beam. (auth)

38055 COMPARISON OF THE PERFORMANCE OF SCINTILLATION CAMERAS AND RECTILINEAR SCANNERS. Cradduck, T. D.; Fedoruk, S. O.; Reid, W. B. (Manitoba Cancer Foundation, Winnipeg. Saskatchewan Cancer Commission, Saskatoon. Nuclear Enterprises Ltd., Winnipeg, Can.). pp 1158-64 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A comparison was made between a scintillation camera and a rectilinear scanner, based on the information available for display. It is shown that in this way various display parameters, such as background subtraction and contrast enhancement, will not affect this comparison since it is based on the fundamental information that is made available. The comparison is of a qualitative nature and uses equipment and facilities available to most radioisotope departments. (B.G.D.)

38056 SURVEY OF SCINTILLATION CAMERA SYSTEMS. Oosterkamp, W. J. (Philips Research Labs., Eindhoven, Netherlands). pp 1150-7 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Various aspects of scintillation camera systems are discussed including detectors, optical-image transfer devices, comparison of gamma cameras and scanners, use of image-intensifier tubes, and positron cameras. The use of spark chambers and Geiger–Mueller counters on gamma cameras is also briefly discussed. (B.G.D.)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 37998, 38029, 38748, 39655, and 39874.

38057 (AE-320) SPECIAL CRYOSTATS FOR LITHIUM COMPENSATED GERMANIUM DETECTORS. Lauber, A.; Malmsten, B.; Rosencrantz, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1968. 18p. Dep.

In many applications of Ge(Li) detectors an extreme design of the cryostat is desirable. One example is a coincidence or anticoincidence setup where the Ge(Li) detector is surrounded by one or several other detectors, usually NaI(Tl) crystals or plastic scintillators. To be usable in this arrangement the part of the cryostat containing the Ge(Li) detector should have the form of a long hood, with the detector placed at its very end. The diameter of the hood should be as small as detector dimensions permit. Excellent energy resolution and reasonably low liquid nitrogen consumption must be retained. Two cryostats fulfilling these conditions will be described. For the first cryostat emphasis lay on the reduction of the hood diameter to an absolute minimum; for the other incorporation of a device regulating the temperature of the cryostat surface was required. The difficulties encountered will be discussed; they were primarily connected with the necessity of combining minimum temperature loss at the detector position with extreme crytostat compactness and cold finger length. The incorporation of a cooled FET transistor in the cryostat will also be described. The gamma spectrometers using the cryostats gave resolutions down to 2.8 keV FWHM for the 1173 keV gamma line from Co 60 and 1.2 keV FWHM for the 122 keV line from Co 57. (auth)

38058 (CEA-R-3405) SPECTROMETRIE γ A HAUTE PERFORMANCE A L'AIDE DE DETECTEURS GE–Li. (High-Performance γ Spectrometry Using Ge(Li) Detectors). Brethon, Jean-Pierre; Libs, Gerard; Detourne, Guy; Legrand, Jean; Boulanger, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 12p. (In French). Dep.

A high resolution gamma spectrometer design which uses Ge–Li detectors, a cooled field effect transistor preamplifier, and a spectrum stabilizer is described. The obtained resolution for the 122keV gamma ray of ^{57}Co is 0.96 keV, and ^{239}Pu, ^{233}Pa, and ^{95}Zr + ^{95}Nb spectra are shown for the example. (auth)

38059 (CONF-670545, pp 69-72) DIE HALBLEITERANORDNUNG IN DER ALPHA-SPEKTROMETRIE. (Semiconductor Installation in Alpha Spectrometry). Flakus, F. N. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). (In German).

The development of α spectrometry beginning with the Rutherford experiments on the deflection of α radiation in magnetic and electrostatic fields is briefly outlined. Proportional counters and ionization chambers are frequently used at present in α spectrometry. The energy resolution obtainable with ionization chambers was compared by Alkazov with that obtainable with semiconductor detectors. The results showed that the semiconductor detector surpasses the ionization chamber with respect to energy resolution capacity and it has a better time resolution also. (J.S.R.)

38060 (CONF-670545, pp 88-95) TRENNUNGEN IN DER AKTIN-URAN-REIHE UNTER VERWENDUNG DER α-HALBLEITER-SPEKTROMETRIE. (Separations in the Actinium–Uranium Series Using α-Semiconductor Spectrometry). Mueller, W. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). (In German).

An anion exchange method was developed for the separation of the long-lived decay products of ^{227}Ac, so that the decay products could be determined by α spectrometry. The preparation of the samples is described. The results obtained with α spectrometry are reported and typical α spectra of ^{227}Ac, ^{211}Bi, ^{223}Ra, and ^{227}Th obtained during the separation are given. The results showed that α spectrometry is a suitable analytical method. (J.S.R.)

38061 (CONF-670545, pp 116-25) SPECIAL SEMICONDUCTOR DETECTORS FOR GAMMA RAY AND PARTICLE SPECTROSCOPY. Den Boer, J. A.; Hofker, W. K. (Philips Gloeilampenfabrieken N. V., Amsterdam (Netherlands). Natuurkundig Laboratorium. Institut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)).

A survey is given of our work on α-particle, β-particle, and γ ray detectors, detectors for biological and in vivo measurements and detectors for $dE/dx \times E$ telescope systems. More in detail the checkerboard detector, a totally depleted semiconductor detector with position indication in two dimensions, will be discussed. (auth)

38062 (CONF-670545, pp 146-55) AUFBAU EINES HOCHAUFLOESENDEN γ-SPEKTROMETERS UND BEISPIELE FUER SEINE ANWENDUNG. (Construction of a High Resolution γ Spectrometer and Examples for its Use). Kemmer, J. (Technische Hochschule, Munich (West Germany), Institut fuer Radiochemie). (In German).

A high resolution γ spectrometer with a Li-drifted Ge crystal was constructed. The Ge crystal, the mechanical structure with cryostats and shielding, and the associated electronics are described. As application of the use of the spectrometer, the γ spectra of the lanthanides ^{154}Eu, ^{159}Gd, ^{160}Tb, ^{110}Ag, and $^{124(127)}Sb$ were obtained and compared with the spectra obtained with a NaI(Tl) crystal. (J.S.R.)

38063 (CONF-670545, pp 171-6) MESSUNGEN VON ROENTGENSPEKTREN MIT GERMANIUM-DETEKTOREN. (Measurements on X-Ray Spectra With Germanium Detectors). Drexler, G.; Perzl, F.; Panzer, W. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg bei Munich. Institut fuer Strahlenschutz). (In German).

Measurements of x-ray spectra with germanium detectors were compared with those obtained with a NaI scintillation detector. The energy dependence of radiation measurement devices in the lower energy range was determined. The results showed that Ge detectors can be used advantageously in the low energy range and more accurate measurements are possible in an area which is of importance both for radiation protection and dosimetry. (J.S.R.)

38064 (CONF-670545, pp 185-90) ANWENDBARKEIT EINES Li^6F-GRENZSCHICHTZAEHLERSPEKTROMETERS ZUR MESSUNG VON SCHNELLEN NEUTRONENSPEKTREN IN ABSCHIRMUNGSSCHILDEN. (Applicability of a ^6LiF Surface-Barrier Counter Spectrometer to the Measurement of Fast Neutron Spectra in Shielding Layers). Stiller, G. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). (In German).

A ^6LiF surface-barrier counter spectrometer was developed for the measurement of fast neutrons in shielding layers. The spectrometer was constructed of commercially available constituents, which are described. The pulse height distributions obtained are shown graphically. The principal disadvantages of the spectrometer are outlined. (J.S.R.)

38065 (CONF-680706-1) MEASUREMENT OF LINAC THICK-TARGET BREMSSTRAHLUNG SPECTRA USING A LARGE NaI SCINTILLATION SPECTROMETER. Sandifer, C. W.; Taherzadeh, M. (EG and G, Inc., Goleta, Calif.). [1968]. 18p. Dep. CFSTI.

From Annual Conference on Nuclear and Space Radiation Effects, Missoula, Mont.

Thick-target bremsstrahlung spectra produced by electron bombardment of a 0.2 radiation-length gold–tungsten target were measured for electron energies in the range of 5.3 to 20.9 MeV. A large NaI spectrometer coupled to a pulse pile-up rejection system measured pulse-height distributions for bremsstrahlung emitted in the forward direction, and a response matrix developed for the spectrometer was used to convert the pulse-height distributions into photon energy spectra. The shapes of the measured spectra show good agreement with those obtained by others for the same target configuration. Apparatus and experimental methods are described and thick-target bremsstrahlung spectra are presented for electron energies of 5.3, 10.0, 14.8, 16.4, 18.2, and 20.9 MeV. (auth)

38066 (EUR-3933) TIME-OF-FLIGHT ANALYZER BASED ON A SMALL ON-LINE COMPUTER. Metzdorf, H. J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1968. 44p. Dep.

A program is described for a small on-line computer used as a neutron time-of-flight analyzer. The structure of its pseudo-code is explained and the details of a sample run are given. (auth)

38067 (EUR-3942) AMELIORATION DES PERFORMANCES D'UN BANC DE COMPTEURS A BF_3 AU MOYEN D'UN CIRCUIT MELANGEUR TRANSISTORISE, POUR UTILISATION DANS DES MESURES PAR TEMPS DE VOL DE NEUTRONS. (Improvement in the Performance of a BF_3 Counter Bank by Means of a Transistorized Mixer Circuit for Use in Neutron Time-of-Flight Measurements). Fraysse, G.; Riccobono, G.; Detcurbet, P. (Euorpean Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1968. 12p. (In French). Dep.

Parallel coupling of BF_3 counters in a bank for time-of-flight measurements presents the two following main inconveniences: the internal capacitances of the counters being added, the pulses get an important attenuation of the signal-to-noise ratio, and the poor amplitude resolution of such an arrangement requires the use of a high discrimination threshold, reducing the detection efficiency. The performances of a single counter can be preserved if each counter is connected with a twin-emitter follower for impedance matching. Then, the pulses are mixed in a transistorized circuit with a low impedance output for the connection with the main amplifier at a large distance. Furthermore, an adjustment of the gain of each way allows the compensation of the differences between the multiplication coefficients of every counter. With such a system, there is the advantage, in the case the γ background is high, to utilize independently in each way a discrimination threshold limiting the final pile-up. The performances of this arrangement are presented and compared to those of a single counter. (auth)

38068 (JINR-P13-3812) RASCHET POGRESHNOSTI SPEKTROMETRA, SVYAZANNOI S FLYUKTUATSIEI FRONTA VKHODNOGO SIGNALA. (Calculation of the Spectrometer Error Due to the Fluctuation of the Input Signal Front). Semenov, B. Yu.; Antyukhov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 19p. (In Russian). Dep.

The minimum limit interval of pulse sequence is considered. Simple formulas with good approximation are obtained for the determination of this interval for the amplifier of the high resolution spectrometer with RC-filters (ordinary and with correction) with various ways of coupling between the amplifier and transformer (direct coupling, through a baseline restorer and through an RC-circuit) with the given measurement error due to tail pile up. The aim of the work is to find the optimal solution in concrete cases of designing, i.e., to choose the most simple system at given requirements to the accuracy and counting rate. (auth)

38069 (JINR-P13-3813) NEKOTORYE VOPROSY POSTROENIYA SPEKTROMETRA PRI POVYSHENNYKH TREBOVANIYAKH K RAZRESHENIYU I ZAGRUZKE. (Some Problems of Constructing a High Resolution Spectrometer with High Counting Rate). Semenov, B. Yu; Antyukhov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 17p. (In Russian). Dep.

The dependence of the measurement error upon T/r (the filter time constant vs input pulse rise time) with the latter's fluctuations for the amplifier with a high resolution spectrometer with RC-filters (ordinary and with correction) with various approximations of the input signal (exponential, parabolic, linear) is studied. Analytical expressions and diagrams are given which are convenient for practical use. A method is suggested for estimating the effect of the transfer functions of amplifying cascades and the analog-digital converter for the measurement error. (auth)

38070 (N-68-17731) CODE CUBED 2: A CODE TO UNFOLD BREMSSTRAHLUNG EXPERIMENTAL DISTRIBUTIONS. Steyn, J. J. (Nuclear Utility Services, Inc., Washington, D. C.). Sept. 1967. Contract NAS5-10337. 225p. (NASA-CR-93210; NUS-395). CFSTI.

A Fortran 4 code for the IBM-7094 computer has been developed to analyze multi-channel pulse-height gamma spectral distributions. The distributions for which the code was developed are those encountered in the measurement of the bremsstrahlung radiation field from volume beta sources, which may consist of a limited number of line spectra in association with the bremsstrahlung. The code generates the detector system response matrix function and applies it to the monoenergetic spectral components discretely and to the bremsstrahlung iteratively. It corrects for iodine K x-ray escape, detector non-linearity, system drift, source decay, background and detection efficiency. The code presents digital results in the form of differential and integrated photon number and energy distributions, and exposure dose. The code optionally outputs spectral data for use as input to a Calcomp plotting program. (auth) (STAR)

38071 MULTICHANNEL ANALYZER IN REGIME OF SEPARATION OF $\alpha-\alpha$ COINCIDENCES. Kuptsov, V. M. (Geological Inst., Moscow). Prib. Tekh. Eksp., No. 2, 108-9(Mar.–Apr. 1968). (In Russian).

An attachment to the ionization or semiconductor α spectrometer was described. It is used to accomplish the backgroundless measurement of the activity of RdAc (^{227}Th) from Th fractions of natural objects by $\alpha-\alpha$ coincidence of the decay products with simultaneous registration of ^{232}Th, Io (^{230}Th), and RdTh (^{228}Th) on the AI-100 amplitude analyzer. (tr-auth)

38072 MAGNETIC SPECTROMETER WITH TWO STRONG-FOCUSING MAGNETS FOR ANALYSIS OF PARTICLES UP TO 6 GeV/c. Vovenko, A. S.; Likhachev, M. F.; Matulenko, Yu. A.; Savin, I. A.; Stavinskii, V. S.; Hsu, Yung-chang (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 26-9(Mar.-Apr. 1968). (In Russian).

The magnetic spectrometry of two strong focusing magnets with field index n = 19 for one magnet and n = −27 for the second was described. The particles during passage through the spectrometer were deflected at an angle of 18°14′. The solid angle of the the spectrometer is 0.4×10^{-3} ster. By variation of the field, the non-linear effects in the spectrometer magnets were reduced, and pulse resolution of 1.5 to 2.0% was obtained. The spectrometer was used for the analysis of particles at pulses up to 6 GeV/c. (tr-auth)

38073 AN ANALYTICAL FUNCTION FOR DESCRIBING GAMMA-RAY PULSE-HEIGHT DISTRIBUTIONS IN NaI(Tl) SCINTILLATORS. Kowalski, B. R.; Isenhour, T. L. (Univ. of Washington, Seattle). Anal. Chem., 40: 1186-93(July 1968).

A continuous, differentiable, analytical function for describing monoenergic gamma-ray pulse-height distributions in NaI(Tl) scintillators has been developed. Digital spectra are treated by computer program LIBSKI which, using a combination of residual least squares and iteration methods, selects the optimum parameters for the individual case based on radioactive statistical criteria. The basic function is the sum of a modified hyperbolic secant representing the photopeak and a quadratic with a modified hyperbolic tangent multiplier for generating the Compton area. Minor interactions produced by bremsstrahlung, backscatter, escape and annihilation radiations are added to the basic function as necessary. The complete function and program LIBSKI are discussed in detail and examples of analytically generated curves fit to experimentally measured gamma-ray spectra are presented. (auth)

38074 ENERGY DEPENDENCE OF CHARACTERISTIC RESOLUTION OF NaI(Tl) CRYSTALS. Mokhir, E. P.; Kravchenko, N. G.; Tsirlin, Yu. A.; Sulyga, A. V. At. Energ. (USSR), 24: 481-3 (May 1968). (In Russian).

The energy dependence of the resolution of 40 × 40 mm NaI(Tl) monocrystals was studied and a simple empirical relation for r(E) crystal resolution and R(E) scintillation spectrometer resolution was found. The measurements were carried out with an installation consisting of a photoelectron amplifier FEU-13 and an amplitude analyzer AI-100 with the following gamma sources ^{60}Co (1.33 MeV), ^{65}Zn (1.11 MeV), ^{54}Mn (0.84 MeV), ^{137}Cs (0.662 MeV), ^{151}Cr (0.32 MeV), ^{114m}In (0.19 MeV), ^{144}Ce (0.142 MeV), and ^{239}Pu (0.051 MeV). The data obtained for spectrometer resolution $R_{exp.}$ and characteristic crystal resolution $r_{exp.}$ were tabulated. The table shows that the divergence between the values rarely exceeded 0.6%. (R.V.J.)

38075 DETERMINATION OF THE ISOTOPE COMPOSITION OF NATURAL AND SLIGHTLY ENRICHED URANIUM BY ALPHA-SPECTROMETRY. Kunzendorf, H. (Danish Atomic Energy Commission, Risoe). Nucl. Instrum. Methods, 63: 152-6(Aug. 1968).

Determinations of the isotope contents of ^{238}U, ^{235}U, and ^{234}U in five uranium samples containing 0–5 at.% ^{235}U were carried out on the basis of a least-squares fit of the α-spectra from the samples, measured with a semiconductor detector, to the theoretically expected α-spectra. With a simple source preparation technique one sample per day can be measured for its ^{235}U content with an accuracy of about ±5%. (auth)

38076 SENSITIVITY OF A NONDISPERSIVE X-RAY FLUORESCENT SPECTROMETER FOR MULTIELEMENT TRACE ANALYSIS. Jones, W. Barclay; Carpenter, Robert A. (Technical Measurement Corp., San Mateo, Calif.). pp 323-33 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The sensitivity of a nondispersive x-ray fluorescent spectrometer for multielemental trace analysis is reported. The method of analysis entails the use of a radioactive source in conjunction with a very high resolution detection system. This instrument is the result of recent advances in solid state detector resolution and associated electronic circuitry. These improvements have made it possible to detect an element in the presence of elements which differ by only one atomic number. The range of sensitivity over most of the period chart and the use of the instrument for remote controlled analyses are discussed. The present examination is on mixtures of parts per million to 5% by weight. The capability of the instrument to perform quantitative analyses of these mixtures is discussed in terms of enhancement and absorption as well as the instrumental limitations of these measurements. The discussion also reveals information on stability, accuracy of data reporting, accuracy of results, and possible sources of ambiguity. (auth)

38077 DOUBLE SCATTER NEUTRON SPECTROMETER. Legge, G. J. F.; van der Merwe, P. (Univ. of Pennsylvania, Philadelphia). Nucl. Instrum. Methods, 63: 157-65(Aug. 1968).

A fast neutron time-of-flight spectrometer with high efficiency has been developed. The time-of-flight between a small cylindrical scatterer and a large spherical shell of liquid scintillator is measured. Because the neutron is scattered twice, a continuous neutron beam can be used with such an instrument. The energy resolution is approximately 10% for neutrons in the range 3 to 10 MeV. The efficiency over the same range is approximately 0.5%. (auth)

38078 AUTOMATION OF THE CORRELATION SYSTEM. Anttila, A.; Sundberg, H. (Univ of Helsinki). Nucl. Instrum. Methods, 63: 215-17(Aug. 1968).

A description is given of the automation of a gamma-gamma directional correlation system with one movable detector; the movable detector runs continuously, and coincidence pulses are fed to a multi-channel analyzer as a function of angle. The system is simple, reliable, cheap, and adaptable to any type of correlation or distribution measurements. Simple automation of the conventional correlation system, in which the movable detector stops at the data angles, is also described. (auth)

38079 NUCLEAR PREAMPLIFIERS AND THE PULSE PILE-UP PROBLEM. Ferrari, A. M. R.; Fairstein, E. (Tennelec Instrument Co., Oak Ridge, Tenn.). Nucl. Instrum. Methods, 63: 218-20(Aug. 1968).

The influence of the preamplifier decay time constant on the resolution of γ-ray spectra is discussed. It is shown that for a preamplifier time constant in the millisecond range and for the full range of γ-ray energies commonly encountered, the system count-rate limitation is never in the preamplifier but in the shaping amplifier which follows it. It is also shown that if the detector is dc-coupled to the preamplifier, the upper count rate limit for a given pile-up level in the preamplifier is degraded by a factor of 10 or more. Even in this mode of operation, the main amplifier sets the upper limit on permissible count rate. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 38174, 38717, 38999, and 39506.

38080 (CERN-Trans-67-8) GENERAL DESCRIPTION OF A GEOMETRICAL RECONSTRUCTION PROGRAM FOR LARGE CHAMBERS ("1-6" VERSION). Govorun, N. N.; Emel'yanenko, G. A.; Markova, N. F.; Moroz, V. I.; Nikitina, V. I.; Santov, I. S.; Stel'makh, A. P.; Tentyukova, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by A. T. Sanders and revised by N. Mouravieff (CERN, Geneva), from report JINR-P11-3480. 21p. Dep.

The geometrical reconstruction program, called 1–6, which takes into account the inhomogeneity of the magnetic field in the chamber, ionization losses, multiple scattering, and bremsstrahlung is briefly described. The program is designed for processing

events with not more than 15 tracks, photographed by a stereo-camera with not more than 6 objectives. It is written in IS-2 machine language for the M-20, BESM-ZM, and BESM-4. (W.H.K.)

38081 (UCRL-16891) DEVELOPMENT OF A HELIUM-FILLED STREAMER CHAMBER SYSTEM. Perez-Mendez, Victor; Stetz, Albert W. (California Univ., Berkeley. Lawrence Radiation Lab.). May 27, 1968. Contract W-7405-eng-48. 23p. Dep. CFSTI.

Development of a helium-filled streamer chamber system is described. Calculations of streamer formation based on two simple models are carried out to determine high voltage pulse requirements. It is found that, with the help of an image intensifier, a Marx generator and resonant charging network can be used to drive chambers of intermediate size. A 1-meter streamer chamber system employing a 350-kV Marx generator is described. This system was used in a recent cyclotron experiment to take 5×10^5 pictures with good resolution and reliability. (auth)

38082 HIGH VOLTAGE GENERATOR FOR SPARK CHAMBER WITH GAP FROM 1 TO 15 cm. Matyushin, A. T.; Matyushin, V. T.; Firkovskii, R.; Khachaturyan, M. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 119-23 (Mar.-Apr. 1968). (In Russian).

A high voltage pulse generator for a spark chamber with gap from 1 to 15 cm was described. The required voltage range was superimposed with a discharge generator, hydrogen thyratron, and generator of the Arcade–Marks type. The calculation, circuits, and characteristics of the generator were given. (tr-auth)

38083 SPECTROMETRIC SCINTILLATION COUNTER. Koshtoev, V. V.; Karapetyan, V. A. Prib. Tekh. Eksp., No. 2, 66-8 (Mar.-Apr. 1968). (In Russian).

A spectrometric scintillation counter with working surface of 50.25 cm^2, ϕ 80 mm, and thickness of 47 mm was described. The counter has an optical heterogeneity of 5.5% and is used to measure the minimum ionization from relativistic particles with a precision of ±16%. The counter was developed for an uncoordinated spectrometer for determining the mass and energy of cosmic particles. (tr-auth)

38084 PRECISION OF THE DETERMINATION OF THE ENERGY OF GAMMA QUANTA IN XENON BUBBLE CHAMBERS. Ivanovskaya, I. A.; Kanarek, T.; Okhrimenko, L. S.; Slovinskii, B.; Strugal'skii, Z. S.; Chuvilo, I. V.; Yablonskii, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 39-44(Mar.-Apr. 1968). (In Russian).

The precision by which the energy of photons in xenon bubble chambers can be determined at 40 to 2400 MeV was analyzed. It was estimated at 12 to 35%. (tr-auth)

38085 ILLUMINATION SYSTEM FOR THE METER BUBBLE CHAMBER PK-300. Aleksanyan, A. S.; Bekker, B. I.; Pikhtelev, R. N. (Erevan Physics Inst.). Prib. Tekh. Eksp., No. 2, 44-7 (Mar.-Apr. 1968). (In Russian).

Two illumination systems for the meter bubble chamber with a volume of 300 l and filled with freon mixtures were described; thermopolar system with use of a simple illumination system of the jalousie type with variable steps and a light polar system with use of Scotchlite. Some characteristics of both systems were reported. (tr-auth)

38086 LIQUID-HYDROGEN BUBBLE CHAMBER WITH DIAMETER OF 50 cm. Ainutdinov, M. S.; Beketov, G. V.; Zombkovskii, S. M.; Konovalov, B. S.; Sedoikin, S. D.; Selektor, Ya. M.; Stepanov, A. M.; Shulyachenko, V. N. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 2, 47-50(Mar.-Apr. 1968). (In Russian).

The construction and basic characteristics of the liquid hydrogen bubble chamber with diameter of 50 cm and depth of 30 cm were described. The chamber was placed in a magnetic field of ~21-Kgauss. The expansion and recompression of the chamber was produced by pistons of 20-cm diameter with condensation mantle of leather. The thermostability of the working volume of the chamber was accomplished by means of three heat exchangers. The precision of the maintenance of the working temperature was 0.05°K. The illumination of the chamber was accomplished by two glass illuminators of 90 mm thickness. Photographing of the chamber was done on perforated film of 80 mm thickness with three objectives with focusing distance f = 150 mm. In typical regime (temperature of the hydrogen in the working volume of the chamber from 26 to 27°K, expansion coefficient of the hydrogen from 0.8 to 0.9%) the false radius of curvature of the track of π^- mesons with pulse of 3.5 GeV/c in the absence of magnetic fields is ~250 to 300 m. (tr-auth)

38087 INVESTIGATION OF THE OPERATION OF THE STREAMER SPARK CHAMBER. Zhankov, I. K. (Tomsk Polytechnical Inst., USSR). Prib. Tekh. Eksp., No. 2, 56-7(Mar.-Apr. 1968). (In Russian).

The operation of the streamer spark chamber was investigated in dependence on the variation of the delay between the passage of cosmic particles and application of the pulse from 1.5 to 500 μsec. (tr-auth)

38088 DETECTOR FOR MEASUREMENT OF THE ENERGY OF ULTRARELATIVISTIC PARTICLES. Lorikyan, M. P. (Inst. of Physics, Erevan). Prib. Tekh. Eksp., No. 2, 29-30(Mar.-Apr. 1968). (In Russian).

A detector for measurement of the energy of ultrarelativistic particles was described. It consists of a system of fine foil jalousies, covered with a porous KCl film, and a system for the measurement of the secondary current. (tr-auth)

38089 WIRE SPARK CHAMBER OF DISCRETE OPERATION. Bekrenev, V. S.; Kruglov, S. P.; Nikolaev, D. L.; Shchetkovskii, A. I. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 2, 54-5(Mar.-Apr. 1968). (In Russian).

A wire spark chamber with a ferrite memory system was described. Information in the form of number of wires was taken out directly to trigger a recorder in binary code. In the case of two or more probes the logic circuit guarantees results of only the coordinates of the last spark. The scanning method used makes it possible to obtain a complete scanning time of the information that is much less than the restoration time of the spark chamber. (tr-auth)

38090 SPARK CHAMBERS WITH 10-cm GAP IN APPARATUS FOR INVESTIGATION OF RESONANCE RADIATIVE DECAY. Matyushin, A. T.; Matyushin, V. T.; Firkovskii, R.; Khachaturyan, M. N.; Khvastunov, M. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 51-4(Mar.-Apr. 1968). (In Russian).

Some chambers with large gaps, used in experiments on the investigation of radiation decay in installations at the VINR synchrophasotron, were described. (tr-auth)

38091 FRAUNHOFER HOLOGRAPHY FOR BUBBLE CHAMBER PHOTOGRAPHY. Thompson, Brian J.; Ward, John H. (Technical Operations, Inc., Burlington, Mass.). pp 649-54 of Modern Optics. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967.

See CONF-670333.

The general problems associated with applying holographic techniques to bubble chamber photography are considered. It appears that Fraunhofer (far field) holography may hold some promise of success. It was attempted to determine the general feasibility of these ideas and to evaluate the pertinent parameters such as resolution, depth of field, etc. The tests conducted simulated bubble chamber conditions by using fixed wires 400 microns in diameter located throughout a chamber 52 in. deep. To more closely simulate conditions in bubble chambers a second experiment was carried out using beads immersed in polyglycol. Reconstructed image characteristics in this case are similar to those obtained using the wires. (auth)

38092 SCANNING AND MEASURING PHOTOGRAPHS OF BUBBLE CHAMBER TRACKS USING A COMPUTER CONTROLLED LINE SEGMENT (PEPR). Watts, Terence L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 207-20 of Pictorial Pattern Recognition. Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Co., 1968.

From Symposium on Automatic Photointerpretation, Washington, D. C. See CONF-670541.

A description of PEPR (Precision Encoding and Pattern Recognition) for the scanning and measuring of photographs of events in bubble chambers is presented. Topics discussed include hardware characteristics element recognition track following, vertex locating, point guidance system, and other operations–precision measuring, ionization, fiducials, and data box. (W.H.K.)

38093 SPARK CHAMBER FILM MEASURING USING THE CHLOE SYSTEM. Hodges, Donald (Argonne National Lab., Ill.). pp 199-205 of Pictorial Pattern Recognition. Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Co., 1968.

From Symposium on Automatic Photointerpretation, Washington, D. C. See CONF-670541.

A brief description of the CHLOE film digitizing system for analyzing spark chamber pictures is given. (W.H.K.)

38094 DAPR-DIGITAL AUTOMATIC PATTERN RECOGNITION FOR BUBBLE CHAMBERS. White, Howard S. (Univ. of California, Berkeley). pp 175-98 of Pictorial Pattern Recognition.

Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Co., 1968.

From Symposium on Automatic Photointerpretation, Washington, D. C. See CONF-670541.

The development of the digital automatic pattern recognition (DAPR) system at LRL for entirely automatic processing of bubble chamber pictures is discussed. The flying spot digitizer (FSD) system and the prototype computer programs are briefly described. (W.H.K.)

38095 CURRENT STATUS OF AUTOMATIC SCANNING AT BROOKHAVEN NATIONAL LABORATORY AND COLUMBIA UNIVERSITY. Rabinowitz, George (Columbia Univ., New York). pp 159-73 of Pictorial Pattern Recognition. Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Co., 1968.

From Symposium on Automatic Photointerpretation, Washington, D. C. See CONF-670541.

Two experiments currently in progress at BNL and Columbia University are described: a kink search program and a search for the rare leptonic decay modes. A flying spot digitizer on-line to an IBM 7094, used for automatic scanning of the bubble chamber film, is discussed. (W.H.K.)

38096 BUBBLE AND SPARK CHAMBERS. PRINCIPLES AND USE. VOLUME I. Shutt, R. P. (ed.) Pure and Applied Physics. A Series of Monographs and Textbooks. Volume I. New York, Academic Press, 1967. 436p.

The theoretical principles and technical aspects of bubble and spark chambers are discussed. Topics include bubble chamber principles, cryogenic bubble chambers, heavy liquid bubble chambers, illumination and photography of bubble chambers, and spark chambers. (B.G.D.)

38097 LONG CHERENKOV COUNTERS MADE OF SOLID AND LIQUID MATERIALS. Richard-Serre, C. (Univ. of Grenoble, France); Saltmarsh, M. J. M.; Measday, D. F. Nucl. Instrum. Methods, 63: 173-81(Aug. 1968).

Long Cherenkov counters made from perspex and freon have been studied, and the application of these counters to the investigation of 120 to 320 MeV/c pion beams has been considered. It is found that the behavior of the counters can be explained in a straightforward manner, and that they can be used to determine the momentum of pion beams, and also the muon and electron contamination of such beams. (auth)

Radiation Dosimeters

Refer also to abstracts 37775, 38052, 38054, and 38387.

38098 (CONF-670545, pp 200-16) NEUTRONENDOSIMETER MIT HALBLEITER. (Neutron Dosimeter With Semiconductor). Wik, M. (Forschungsanstalt der Schwedischen Landesverteidigung, Stockholm). (In German).

A neutron dosimeter in the form of a special semiconductor diode was developed for the detection of neutrons from nuclear bomb explosions or nuclear reactors. The current-voltage characteristics of diode type D1-3-0 were modified by fast-neutron irradiation. A schematic is given of the diode. The voltage-current characteristics before and after irradiation were determined. A theory of the voltage-current characteristics was developed. First test results to verify the theory were good. (J.S.R.)

38099 (CONF-670545, pp 217-27) SILIZIUMDIODEN ZUR INTEGRIERENDEN MESSUNG SCHNELLER NEUTRONEN IN DER PERSONENDOSIMETRIE. (Silicon Diodes for the Integrated Measurement of Fast Neutrons in Personnel Dosimetry). Becker, K. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Some practical aspects of semiconductor neutron dosimeters were reported in which the integrated flux of fast neutrons was measured over the decrease of the charge carrier lifetime in the base region of p-i-n silicon diodes. Some results obtained with the relatively sensitive commercially manufactured diodes PH-50 were reported. (J.S.R.)

38100 (KFKI-12/1968) PERSONAL FAST NEUTRON MONITORING BY USE OF KODAK NTA FILMS. Bekes, E. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1968. 11p. Dep.

Investigations in connection with routine dose measurements for personnel fast neutron monitoring are reported. The energy and angular dependence as well as the fading of the Kodak NTA track film applied in the measurement have been evaluated. The film measures doses and energies from 0.05 to 10 rem and from 0.5 to 14 MeV, respectively, provided the gamma dose does not exceed 1 R. (auth)

38101 (LA-3889) THE NEW LASL FILM BADGE AND PERSONNEL NEUTRON DOSIMETRY PACKET. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 27p. Dep. CFSTI.

Descriptions of the new LASL film badge with multielement filters and the personnel neutron dosimetry packet which consists of various activation foils for criticality accidents are given. Also, recommendations for the proper use of film badges are presented. (auth)

38102 (MLM-1490) LATENT IMAGE FADING IN PERSONNEL NEUTRON MONITORING FILM. Meyer, C. T. (Mound Lab., Miamisburg, Ohio). Sept. 8, 1967. Contract AT(33-1)-Gen-53. 7p. Dep. CFSTI.

Latent image fading in neutron personnel monitoring film was investigated for two weeks. One hundred and twenty pieces of neutron film were packaged in film badges and exposed to a plutonium fluoride source at various time intervals. There was 33% fading of neutron tracks after one week and 56% fading of neutron tracks after two weeks. The one- and two-week exposures approximate the radiation exposure which would be received during some weeks by personnel in those groups exposed to low energy neutrons. The results indicate that calibration films should be exposed on the third day of the week if badges are exchanged weekly and exposed on the fifth day of the first week if changed bi-weekly. (auth)

38103 (TID-24522) THERMOLUMINESCENT DOSIMETERS FOR PERSONNEL MONITORING. Attix, F. H.; West, F. J.; Nash, A. E.; Gorbics, S. G.; Johnson, T. L. (Naval Research Lab., Washington, D. C.). [1968]. 11p. Dep. CFSTI.

A number of thermoluminescent phosphors are suitable for application in personnel radiation monitoring. The principal characteristics of LiF (TLD 100), CaF_2: Mn, CaF_2 (fluorite), $Li_2B_4O_7$: Mn, $CaSO_4$: Mn, and BeO are summarized. Some useful dosimeter configurations are also discussed, including a new NRL dual-phosphor design that is capable of measuring the x-ray or gamma-ray effective energy as well as the exposure or dose. Relative performance results for CaF_2: Mn dosimeters versus film badges are also included. (auth)

38104 (TID-24523) THERMOLUMINESCENT DOSIMETERS OF LITHIUM BORATE. West, F. J.; Nash, A. E.; Attix, F. H.; Kirk, R. D.; Schulman, J. H. (Naval Research Lab., Washington, D. C.). [1967]. 5p. Dep. CFSTI.

It has been suggested previously that manganese-activated lithium borate ($Li_2B_4O_7$: Mn) might be applicable for use in medical therapy dosimetry in place of lithium fluoride. Various modifications in preparation procedures have been tried, notably the substitution of each of eleven other activators for manganese, but none of them approached its effectiveness. Batch variations have been virtually eliminated by increasing batch size to 75 grams and using platinum ware exclusively. The main drawback of lithium borate in dosimeter applications has been the supralinearity of its response-versus-exposure curve above about 200 roentgens. Exploratory measurements have been made to improve the linearity by means of prior irradiation and annealing treatments, and the method has been found promising enough to warrant further work to optimize this procedure. The cause of the sensitivity enhancement in lithium borate has been found to be the creation, by radiation damage, of new energy traps which give rise to a thermoluminescent glow peak at about 220°C. The response of this phosphor was measured from 40 to 170 keV and compared with that for ^{60}Co gamma rays. Results show greater responsiveness to x rays than predicted on the basis of energy absorption coefficients. (auth)

38105 INVESTIGATIONS ON SOLID STATE DOSIMETERS FOR NEUTRONS. Jeltsch, E. (Kerforschungsanlage, Juelich, Ger.). Atomkerenergie, 13: 289-93(1968). (In German).

After some general considerations on non-nuclear dose measuring systems for neutrons, especially on their spectral sensitivity, Al_2O_3 and W dosimeters are thoroughly discussed as examples for systems of light and heavy atomic nuclei. (auth)

38106 IDENTIFICATION BADGE DOSIMETER. Brady, William J.; Iverson, Garn K. (to United States Atomic Energy Commission). U. S. Patent 3,393,318. July 16, 1968.

A film badge and security credential holder for monitoring mixed radiation fields including gamma, beta, thermal neutrons and fast neutrons is described. It is also used for criticality high-range dosimetry with front exposure to back exposure density equivalence using a plurality of radiation dosimeters such as films, fluorod, sulfur tablet, copper plate, and indium plate together with various combinations of filters with varying thickness such as Teflon, tantalum and cadmium. (AEC)

38107 IMPROVEMENTS IN OR RELATING TO PULSE SPECTROMETRY. (to Gesellschaft zur Foerderung der Fors-

chung an der Eidgenoessischen Technischen Hochschule). British Patent 1,114,951. May 22, 1968. Priority date June 4, 1964, Switzerland.

Gain stabilization circuits utilizing a reference source for scintillation gamma spectrometers are described. (W.H.K.)

38108 RADIOACTIVE RADIATION DOSIMETER OF THE SILVER PHOSPHATE GLASS TYPE. Bryer, Robert George (to R. A. Stephen and Co., Ltd.). U. S. Patent 3,385,968. May 28, 1968. Priority date May 21, 1962, Great Britain.

Design of the casing and shielding configuration for a portable dosimeter of the silver phosphate glass type is presented. (TSS) (U. S. Pat. Gazette)

38109 MATHEMATICAL THEORY OF RADIATION DOSIMETRY. Fitzgerald, J. J.; Brownell, G. L.; Mahoney, F. J. New York, Gordon and Breach Science Publishers, Inc., 1967. 755p. $30.25. (TID-24538).

A textbook directed to first- and second-year graduate students in engineering science and health physics is presented. The titles of the chapters which sufficiently describe its contents are: Introduction to Radiation Dosimetry, Summary of Pertinent Radiation Physics, Summary of Pertinent Radiation Biology, Interactions of Gamma Radiation with Matter, Gamma Radiation Dosimetry, Interactions of Neutron Radiation with Matter, Neutron Radiation Dosimetry, Beta Radiation Dosimetry, High Energy Particle and Heavy Charge Particle Radiation Dosimetry, Background Material for Internal Radiation Dosimetry, and Radiation Dosimetry of Internal Emitters. (B.G.D.)

38110 GLASS ELEMENT FOR DOSIMETERS. Yokota, Ryosuke; Nakajima, Saburo; Fukui, Toshio; Fukunda, Kiyoshi (to Tokyo Shibaura Electric Co. Ltd.). British Patent 1,119,815. July 10, 1968. Priority date Feb. 28, 1966, Japan.

An improved glass composition is described for use in photoluminescent dosimeters for beta-, gamma-, and x-ray dosimetry comprised of beryllium metaphosphate and lithium metaphosphate in the relative proportions by weight from 1:4 to 4:1 and from 1 to 10% by weight of silver metaphosphate based on the combined weights of the beryllium metaphosphate and lithium metaphosphate. The glass composition is said to have a higher sensitivity and a markedly reduced energy dependency as compared with known glass composition and it enables small radiation doses to be measured accurately. The glass composition also has good durability against moisture and weathering. (auth)

38111 DEVICE FOR OBSERVING THE FLUORESCENCE OF A SPECIMEN, IN PARTICULAR OF A DOSIMETER GLASS. Aouizerate, Marc; Portal, Guy (to Commissariat a l'Energie Atomique). British Patent 1,119,622. July 10, 1968. Priority date Dec. 10, 1965, France.

A device is described for observing the fluorescence produced in a photoluminescent dosimeter. The device contains a photomultiplier for use as the detector and an ultraviolet radiation source for de-excitation. (B.G.D.)

38112 GAMMA-RAY SPECTROMETER FOR SPACE APPLICATIONS. Marshall III, J. Howard (Analog Technology Corp., Pasadena, Calif.); Weeks, Donald R.; Halpern, Edward. pp 98-106 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Development of a gamma spectrometer for earth-orbiting satellites for measuring gamma radiation emitted by astronomical bodies is presented. The detector system consists of a collimated array of 48 lithium-drifted germanium detectors. (W.H.K.)

38113 INFLUENCE OF THIN AIR-EQUIVALENT LAYERS ON THE PRESSURE DEPENDENCE OF THE MEAN ION DOSE RATE. Engelke, Berth-Arnim; Oetzmann, Werner (Physikalisch-Technische Bundesanstalt, Brunswick). pp 719-31 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

If the atomic number of a medium B, within which the ion dose rate $d^2Q/(\varrho_L \cdot dV \cdot dt)$ is measured with a cavity ionization chamber, is different from that of air, the mean value of the ion dose rate will depend on the mass of the air, i.e., on size of the measuring volume and the density of the air. The reason for this effect are the δ-electrons. This unwished volume—or density dependence can be removed if a thin layer of an air-equivalent material is brought between the air in the measuring volume (cavity) and the surrounding material (chamber walls and the medium B). The investigations are made with ^{137}Cs- and ^{60}Co-γ-radiation and 30 and 45 MeV x-radiation with layer thickness of aluminum, graphite, and polystyrene between 0.1 and 10 μm and air pressures between 50 and 760 Torr. (auth)

38114 INTERFACE DOSIMETRY WITH LiF-TEFLON MICRODOSIMETERS. Schulz, R. J. (Albert Einstein Coll. of Medicine, New York). pp 643-98 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

Thermoluminescent LiF-Teflon microdiscs were used to measure the effect of high atomic number materials on the dose delivered to thin slabs of low Z material that are in direct contact. Essentially plane geometry is obtained (the microdisc thickness to diameter ratio is 0.001) and the microdiscs were irradiated between flat slabs of Lucite, Teflon, and aluminum with 100 keV x-rays and ^{60}Co gamma rays. (W.H.K.)

38115 USE OF BIOLOGICAL DOSIMETERS FOR THE DETERMINATION OF DOSE AT THE INTERFACES. Wambersie, A.; Dutreix, J. (Institut Gustave-Roussy, Villejuif, France). pp 602-20 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In French).

See EUR-3747; CONF-671109.

Measurements made with the aid of a parallel-plate ionization chamber have revealed a rapid variation of the ionization near the interfaces between two media of different composition. In order to confirm that the ionization measurements really represent the variations in the absorbed dose, these measurements were repeated with two other types of detectors, the chemical dosimeter $FeSO_4$ and a biological dosimeter, E. coli bacteria. For technical reasons these measurements could only be performed with 20 MeV photons. They confirm the results obtained with the ionization chamber. The interest of the biological dosimeters is discussed for some applications in radiobiology and radiotherapy. (auth)

38116 NEW DEVELOPMENTS IN PHOTOLUMINESCENT MICRODOSIMETER MEASUREMENT. Kastner, J.; Cameron, B. A.; Paesler, M. A.; Langs, R. K. (Argonne National Lab., Ill.). pp 621-32 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The factor which has limited the sensitivity of photoluminescent dosimetry has been the predose or matrix fluorescence background which is stimulated during readout by the usual continuous ultraviolet exposure. The signal-to-noise ratio has only been partially optimized by selective choice of filters and optical geometry. A microdosimetric system was conceived and investigated which is potentially capable of sensing extremely low radiation dosages (in the order of microrads). This system depends on the little-known fact that the decay time for the visible luminescence, which is a measure of the absorbed dose, is at least ten times longer than the decay of the indistinguishable visible fluorescence (to U-V) which is an inherent characteristic of unexposed silver phosphate glasses. A 2 to 1 signal-to-noise ratio from a Toshiba fluorod exposed to 10 mR was obtained. (auth)

38117 INFLUENCE OF INTERFACES ON DOSIMETER RESPONSE. Burlin, T. E.; Chan, F. K. (Polytechnic, London). pp 447-59 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

A dosimeter is rarely identical with the medium in which the absorbed dose is to be measured. When an unmatched dosimeter is placed in a medium its response will be modified due to interface effects. The magnitude of the interface effects on the dosimeter response will be a function of the size of the dosimeter relative to the range of the directly ionizing particles. A theory, which accounts for interface effects, was examined experimentally on several different dosimeters and results covering a large range of dosimeter size and atomic number are presented. (auth)

38118 VACUUM CHAMBER AS AN INTERFACE DOSIMETER. Burlin, T. E.; Hancock, B. W. (Polytechnic, London). pp 461-72 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The electron degradation spectrum of electrons in an irradiated medium passes between the electrodes of a vacuum chamber. A polarizing voltage can be applied to differentiate between low and high energy electrons. The effect of the low energy and high energy electrons on the response of the vacuum chamber is discussed. If the current due to low energy electrons is measured

it provides an indication of the absorbed dose near the surface, since these low energy electrons emerge from a surface layer of 100 Å thickness or less. A method of measuring the low energy electron current from one material of an interface is described. Thus the absorbed dose in a very thin layer immediately adjacent to an interface between two materials is derived. Some experimental results are presented. (auth)

38119 MICRODOSIMETRY IN CYLINDRICAL VOLUMES: INTERIM REPORT ON A PROJECT USING A TISSUE EQUIVALENT PROPORTIONAL COUNTER. Bevan, John S. (Borough Polytechnic, London). pp 161-87 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

A theoretical treatment of the path length distributions for charged-particle deposition of energy in small tissue-equivalent cylindrical volumes is given, and the design and performance of a tissue-equivalent proportional counter are presented. (W.H.K.)

38120 BIOLOGICAL SIGNIFICANCE OF SHAPE AND VOLUME OF MICRODOSIMETERS. Fowler, J. F. (Hammersmith Hospital, London). pp 93-124 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed,). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

An attempt to correlate biological effect of radiation with local energy density is discussed. The various physical parameters used were target volume, target shape, threshold local energy density (or graded injury), quality of radiation, whether more than one target is present, and the integrating time or repair rate. In selecting various shapes and volumes for testing the correlations, available experimental results were interpreted by different biophysical models. (B.G.D.)

Radiometric Instruments

38121 CIRCUIT FOR DETECTING PERIODIC VARIATIONS SUPERIMPOSED UPON A TRAIN OF OTHERWISE RANDOMLY DISTRIBUTED PULSES. Walker, David Arthur (to Rolls-Royce Ltd.). British Patent 1,118,474. July 3, 1968. Filed June 1, 1967.

A tachometer circuit for visual or graphic display of the revolution rate of a gas turbine engine is presented. A clock pulse generator is used in the circuit to analyze the pulses from a scintillation detector which detects the revolutions of a radioactive ball bearing in the gas turbine engine. Block diagrams are included. (W.H.K.)

38122 NEUTRON THERMALIZATION ANALYSIS. Nelligan, William B. (to Schlumberger Tech. Corp.). U. S. Patent 3,385,969. May 28, 1968. Filed Sept. 11, 1962.

A method for deriving indications of the molecular composition or state of hydrogen compounds in earth formations traversed by a borehole is described. It consists of irradiating the formations with successive bursts of relatively fast neutrons from a source in the borehole, detecting neutrons returning to the borehole at first and second points spaced at different distances from the source, said neutrons being detected at each of the points intermediate such bursts with energies which are substantially solely in at least one preselected band having a lower limit slightly above the energy of thermal equilibrium and an upper limit less than 1.0 electron volt, and recording indications correlated with depths which vary in accordance with the rate at which neutrons are detected at each of said points in the preselected energy band. (U. S. Pat. Gazette)

38123 ALPHA PARTICLE PRESSURE GAUGE FOR HIGH ALTITUDE CONSTANT LEVEL BALLOON FLIGHTS. Howard, R. L.; Nelson, S. W.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Rev. Sci. Instrum., 39: 1013-18(July 1968).

An alpha particle pressure gauge designed for use on very high altitude constant level balloon flights is described. The instrument gives continuous readings from sea level to pressures less than 1 millibar with an accuracy in the 1-10 millibar range of a few tenths of a millibar. The instrument utilizes a sensitive electrometer measuring the ionization current due to a very weak polonium alpha particle source of less than 1 μCi in the form of nonreactive ceramic microspheres. The pressure is read out by the time interval between resets of the drifting electrometer in a form convenient for transmitting by radio telemetry. Temperature compensation in the electronic circuitry corrects for the gas law so that the instrument measures pressure independent of temperature to suitable accuracy between −25 and +25°C. The instrument has been tested on more than 50 balloon flights and gives reproducible and accurate results. The complete physical and electronic operating principles are described and detailed drawings and photographs of the improved version sufficient to enable the experimenter to construct a copy are shown. The instrument uses all solid state components and the size, weight, and power requirements are very small. (auth)

38124 TEST RESULTS OF A SEMICONDUCTOR DETECTOR NUCLEONIC FUEL GAGE. Hoalst, K. M.; Webster, J. R. (General Nucleonics Corp., Claremont, Calif.). pp 19-24 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Engineering evaluation of Nucleonic Mass Metric Fuel Gage has been performed for ultimate use on large high performance jet aircraft. The instrument consists of four major subassemblies: a radioactive source, an integrated semiconductor detector/preamplifier, processing electronics, and readout/indicator. Evaluation was performed using a simulated C-133 wing tank capable of containing over 9,450 pounds of JP-4 jet fuel. Attitude evaluation included pitch and roll up to 20°, and environmental evaluation was that experienced during the three month testing period: temperature 10 to 41°C, humidity 40 to 95%. (auth)

38125 PRACTICAL APPLICATIONS OF NEUTRON RADIOGRAPHY IN NONDESTRUCTIVE VISUAL EXAMINATION OF AEROSPACE HARDWARE. Meyer, Bruce C.; Porter, Charles (General Electric Co., Pleasanton, Calif.). pp 254-8 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Neutron radiography has important useful applications in nondestructive visual examination of many critical aerospace components. Some examples of these applications include: visual inspection of explosive ordnance devices to ensure the proper placement of epoxies and the integrity and presence of the explosive itself, detection of hydrogen inclusions in titanium weld joints, inspection of certain electronics components, inspection of epoxy bonded honeycomb structures, and inspection of boron fiber composite materials. How a neutron radiograph is made, a number of examples of interest to the aerospace field, and practical use of this technique to solve many non-destructive testing problems are discussed. (auth)

38126 RECENT APPLICATIONS OF NUCLEAR METHODS AND TECHNIQUES TO AERODYNAMIC TESTING. Polishuk, P.; Beavin, R.; Gorrell, J.; Singhal, N. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). pp 259-66 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Various nuclear methods and techniques used in aerodynamic testing are outlined. Topics discussed include activation analysis; kryptonation; vehicle characterization; and position, orientation, and environmental density determination. (W.H.K.)

38127 ELECTRON BACKSCATTER FOR CORROSION DETECTION. Frasca, A. J.; Bemisderfer, C. H.; Krause, C. E. (Industrial Nucleonics Corp., Columbus, Ohio). pp 221-9 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The construction of a radiometric gauge utilizing electron backscatter for corrosion detection is described. The gauge is designed to scan through epoxy paint coating and determine the condition of the metal surface. With aluminum aircraft parts, the gauge, as it is now designed, can measure corrosion depths up to 20 mils and as small as 2 mils. The configuration chosen for the gauge consists of a moving source traveling in an oscillatory manner (path length 4.5 inches) between two scintillators. These scintillations are summed by light coupling to two photomultiplier tubes. The electrical pulses from these tubes are then processed by a digital to analog technique using tunnel diode discrimination techniques. (W.H.K.)

38128 AIRCRAFT ENGINE ISOTOPE RADIOGRAPHIC INSPECTION USING SOURCE COLLIMATION. Packer, L. Leonard; McKenzie, Robert D.; Bruton, William A. (United Aircraft Research Labs., East Hartford, Conn.). pp 216-20 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The potential applications of isotope radiography for aircraft

engine inspection are extended by the use of source collimation. By restricting the gamma-ray beam to intercept only the area under inspection, the reduction in Compton scattering improves image resolution and provides definition of engine structure not possible with an uncollimated source. The construction of the collimator and specific applications of this technique are described. (auth)

38129 FORMATION FLIGHT USING HIGH QUANTUM ENERGY RADIATION. Rubinstein, Robert I. (Army Electronics Command, Fort Monmouth, N. J.). pp 358-64 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The advantages of utilizing various high energy radiation approaches to formation flight operations are explored. Some of these advantages are: all weather, high short range accuracy, security, countermeasure immunity and spectrum conservation. Specifically considered are the potentials of isotope generated gamma and Bremsstrahlung radiation and tube generated x rays. Tube generated x rays are explored in both c-w and pulsed modes of operation. The disadvantages of c-w operations have further narrowed the Army's program to a thorough exploration of the potential of pulsed modes of operations. The program consists of exploring both amplitude and time of flight methods of pulsed operations for range determination. (auth)

38130 C-5A ENGINE OIL QUANTITY INDICATING SYSTEM. Callaway, R. L. (Lockheed-Georgia Co., Dawsonville, Georgia). pp 25-8 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The C-5A oil gage measures oil quantity in the General Electric T-F-39 engine oil tank between 0 to 60 pounds. This paper deals with source selection, detector selection, certain considerations used in circuit design, and the accuracies obtained under various environments such as temperature, shock, acceleration, vibration and various attitudes of pitch and roll. (auth)

38131 NUCLEAR TECHNIQUES FOR MEASURING PROPELLANT MASS ABOARD ORBITING SPACE VEHICLES. Pfeifer, R. J.; Cho, B. Y.; Evans, H. J. (Industrial Nucleonics Corp., Columbus, Ohio). pp 29-39 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

A means of sensing the amount of propellant in the fuel tanks of an orbiting space vehicle irrespective of the magnitude of acceleration forces on the propellant is described. A sampling technique is discussed particularly appropriate for the measurement of mass in cylindrical and hemispherically-capped cylindrical tanks in which a large spherical vapor bubble exists. The tank is sampled along various lines parallel to the axis of the tank, the amount of propellant in the liquid and vapor phases along the lines being determined by nucleonic means. The pattern of the sampling lines have been optimized through computer studies for arrays of seven to fifteen sampling lines located parallel to the axis of the tank. The average absolute errors encountered range from 0.5 to 2.0 per cent of tank capacity and maximum errors range from 2 to 5 per cent of tank capacity for the random location of a spherical vapor bubble of various sizes within the tank. Numerical results for over 200,000 individual cases are summarized in various error distributions. Gamma transmission techniques are applicable for the measurement of hydrogen, while extended line sources and detectors must be employed for the measurement of oxygen. The advantages and disadvantages of nuclear monochromatic gamma and X-ray sources are discussed. (auth)

38132 NUCLEONIC MEASUREMENTS OF CRYOGENIC DENSITIES AND QUALITIES. Scheiwe, J. P.; Cho, B. Y. (Industrial Nucleonics Corp., Columbus, Ohio). pp 40-7 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Industrial Nucleonics Corporation has designed and built nucleonic gauges which have been used to measure the density and quality of low temperature hydrogen. Liquid hydrogen density data from measurements made with a fast response densitometer made at the Marshall Space Flight Center by NASA personnel are presented. Also reviewed are data on slush hydrogen densities obtained at the National Bureau of Standards in Boulder, Colorado. Liquid-vapor quality data obtained from a Saturn S-IVB flight are also presented. A correlation between these data, obtained from the cryogenic quality meter and data obtained from the on-board TV monitoring system, is reviewed. (W.H.K.)

38133 ISOTOPIC PROPELLANT LEVEL INDICATOR FOR SMALL ARMS LOADED ROUNDS. Pollock, Earl M. (Nuclear Research Corp., Southampton, Pa.); Fujita, Michio; Kuser, Harry C.; Inglis, Warren. pp 58-64 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The purpose of the project was to detect the presence or absence of propellant in small arms loaded rounds in a non-destructive manner on a 100% inspection basis. Results obtained showed that isotopic gauging techniques can accomplish this at rates in excess of 250 pieces a minute in conjunction with special mechanical handling devices developed in the course of investigation. Separation or detection of propellant levels in cartridges of 5.56 mm, 30 caliber and 7.62 mm differing by ±.10" from a preselected cartridge case was readily accomplished. Scintillation techniques and high-speed solid state electronics as well as isotopic sources were used. (auth)

38134 SMALL AMPLITUDE VIBRATION CALIBRATION USING THE MOESSBAUER EFFECT. Netusil, W. F.; Witherspoon, J. E. (Rocketdyne, Canoga Park, Calif.). pp 65-79 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

The measurement of vibrational displacement amplitudes in the angstrom range at frequencies in the kilohertz range are beyond the present calibration capability of optical methods. This situation can be improved simply by measuring velocity variations with sensitive equipment in place of displacement amplitude. Then by integration of the velocity data, peak displacement amplitude can be calculated and by differentiation peak acceleration, can be obtained provided, as with the optical methods, the relationships for simple harmonic motion are applicable. An experimental feasibility study, sponsored by the Test Laboratory of George C. Marshall Space Flight Center of NASA, to utilize the Moessbauer effect for this purpose is presented. (W.H.K.)

38135 X-15 X-RAY AIR DENSITY SENSOR. Johnson, Donald L.; Murakami, Eugene (General Nucleonics Corp., Claremont, Calif.). pp 95-7 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Description of an x-ray air density sensor to be flown in the right wing tip pod of an X-15 aircraft is presented. The purpose is to measure free-stream air density continuously from sea-level to an altitude of 300,000 feet to an accuracy of ±5% of reading. Air density is measured directly over a density dynamic range of almost six orders of magnitude using an x-ray scatter technique. The sensor consists basically of an x-ray tube source, a radiation detector and data processing and conditioning electronics. Data outputs are recorded on the onboard optical oscillograph and tape recorders. For these tests the free stream air density data will be processed on the ground. The sensor has been designed, fabricated and functionally tested. Environmental testing and altitude chamber calibration will be performed, before flight testing in the X-15 aircraft. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 37965, 38648, 38820, and 39080.

38136 (APDA-222) FEASIBILITY STUDY OF IN-LINE DETECTOR FOR HYDROGEN IN SODIUM. Coleman, J. H.; Hill, E. F. (Atomic Power Development Associates, Inc., Detroit, Mich.). Mar. 1968. Contract AT(11-1)-865. 45p. Dep. CFSTI.

The principle of the detector involves using a catalytic surface to oxidize hydrogen to water as it emerges from a diffusion membrane which is in contact with liquid sodium containing hydrogen. Surface oxidation creates a hydrogen pumping action; the amount of water formed is proportional to the amount of hydrogen contained in the sodium, thus providing a measure of hydrogen concentration. The results of the laboratory program showed that the principle is applicable to the detection and removal of hydrogen in sodium and that a quantitative relationship exists between the hydrogen contained in sodium and the amount of water formed in the oxidizing gas. A relationship was shown to exist when hydro-

gen was added as a gas, as sodium hydroxide, as water, and as sodium hydride. (W.H.K.)

38137 (BNWL-773) WIDE-ANGLE INFRARED RADIOMETER FOR RADIOACTIVE WASTE MONITORING. Jensen, J. D.; Green, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

An infrared radiometer system which monitors the temperature of stored radioactive waste materials is described. The temperature monitoring system indicates an overtemperature condition when 1.8% or more of the area of the stored waste rises 150°C above the 100°C background temperature in the storage tank. The system will also yield an output indication if the entire bottom temperature varies ±1°C from its ambient temperature. Effects of water vapor absorption on the incoming infrared energy and effects of temperature on the infrared radiometer are discussed. (auth)

38138 (CONF-670545, pp 62-7) ERFAHRUNGEN MIT EINEM GEKUEHLTEN FET-VORVERSTAERKER MIT EXTREM NIEDRIGEM RAUSCHEN. (Experiences With a Cooled FET Preamplifier With Extremely Low Noise). Tamm, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). (In German).

The circuit of a FET preamplifier is given and described. Its noise contribution was experimentally determined and the results were compared with those calculated. The optimum time constants can be determined from the individual noise constituents. The preliminary experiments made with this preamplifier are briefly outlined. (J.S.R.)

38139 (DESY-68/21) GRAZING INCIDENCE VACUUM ULTRAVIOLET MONOCHROMATOR WITH FIXED EXIT SLIT FOR USE WITH DISTANT SOURCES. Kunz, C.; Haensel, R.; Sonntag, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Apr. 1968. 7p. Dep.

An ultraviolet spectrograph mounting, designed to overcome the normally encountered disadvantages of the overlapping of higher orders and the continuous change of the exit or entrance path of light, is described. The monochromator is composed of a system of rotating spherical or paraboloidal mirrors and grating. (W.H.K.)

38140 (GAT-571) PORTABLE $^{235}U/^{238}U$ ISOTOPIC MASS SPECTROMETER FOR PROCESS CONTROL. Davis, P. I.; Lang, J. (Goodyear Atomic Corp., Piketon, Ohio). Apr. 1, 1968. Contract AT(33-2)-1. 16p. Dep. CFSTI.

A portable, automatically-operated mass spectrometer has been designed and evaluated for providing onstream ^{235}U analyses for control of a UF_6 withdrawal stream; on-line relative precision of 0.039 percent in the range of 2 percent by weight of ^{235}U has been achieved. Analysis of an unknown sample requires 12 minutes, and instrument scalers for two standards and for the unknown sample are digitally displayed for subsequent computation of assay by an interpolative method. Reduced gas sample flow extends the service life of the electron-bombardment ion sources so that the sources are capable of over 2500 determinations. The analyzer is a stainless-steel tube differentially pumped with sputter-ion high-vacuum pumps. Mobility for use throughout cascade areas is provided by a four-wheel, temperature-and-humidity-controlled environmental trailer weighing 7000 pounds. At present, necessary withdrawal assay adjustments are accomplished manually as indicated by spectrometer analyses (open loop control); however, development of a fully automated system for controlling withdrawals (closed loop control) is under study. (auth)

38141 (IDO-17268) FISSION COUPLE CRYOGENIC APPLICATIONS FEASIBILITY STUDY. Stanley, M. L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1968. Contract AT(10-1)-205. 40p. Dep. CFSTI.

The problem of fission couple application at cryogenic temperatures is investigated with consideration given to heat generation per fission, fissile size, gamma compensation, burnup, radiation hazard, heat losses, and signal output at various neutron flux levels. Models are developed using simple one-dimensional heat transfer theory, and maximum signal outputs are calculated as a function of neutron flux levels. The variation in thermal conductivity with temperature is included in the analysis. The conclusion is reached that fission couples are applicable at cryogenic temperatures when heat loss is a major part of their design criteria. (auth)

38142 (LA-DC-9004) VAPOR DEPOSITION IN THE FABRICATION OF FISSION THERMOCOUPLES. Fairchild, C. I.; Bertino, J. P.; McCreary, W. J.; Salgado, P. G. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 12p. (CONF-680202-5). Dep. CFSTI.

From 97th Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, New York

Fission thermocouples were used to measure the thermal properties of porous pyrolytic carbon and to measure neutron flux in nuclear reactors. Each fission thermocouple consisted of a fissionable particle to which thermoelements of 0.0005 in. diam chromel/alumel wire were welded. Vapor deposition techniques were employed to coat the fissionable particles with protective pyrocarbon as well as porous pyrocarbon for thermal measurements, and with tungsten outer layers to provide weldable surfaces. Uranium dicarbide particles were coated in a fluidized bed with 50–200 μ of carbon by pyrolysis of acetylene at 1000°C and of methane at 1400°C. A tungsten layer, 1–5 μ thick, was then deposited on the PyC–UC_2 particles in a fluidized bed by the H_2 reduction of WF_6 at 500°C and 50–200 torr pressure. Uranium dioxide particles were coated with tungsten by H_2 reduction of WF_6 or WCl_6. The thermal conductivity of a porous pyrocarbon coating was determined using fission thermocouples, to be 0.0015 cal cm^{-2} sec^{-1} $(°C/cm)^{-1}$. (auth)

38143 (N-68-18254) OPERATIONAL AMPLIFIERS FOR USE IN NUCLEAR SPECTROSCOPY. Fessler, Theodore E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 28p. (NASA-TN-D-4349). CFSTI.

The design of pulse amplifier systems for use in nuclear research can be greatly simplified by the use of fast operational amplifiers. The design and use of operational amplifiers in circuits with rise times as low as 10 nanoseconds are described. A specific amplifier circuit is used to illustrate real amplifier performance. Phase-compensation methods and their relation to open-loop amplifier properties are described. Some closed-loop amplifier circuits are used to demonstrate practical phase compensation. (auth) (STAR)

38144 (NP-17501) STRIP-CHART TO PUNCHED TAPE TRANSLATOR. Research Laboratory Report No. 6075. Jenkinson, G. F. (Postmaster-General's Dept., Melbourne (Australia). Research Labs.). Oct. 28, 1966. 19p. Dep.

A strip-chart translator was developed to convert complex strip chart records (for example, those obtained from radio propagation tests) into digital format, on punched tape, to allow analysis by electronic computer. An operator is required to follow the chart trace with a cursor mark, but the translation process is otherwise automatic. The detail contained in such record traces has so far precluded the use of a fully automatic translation process. (auth)

38145 (ORNL-TM-2195) TRANSIENT ANALYSIS OF TRANSISTORIZED LOGARITHMIC AMPLIFIERS. Tangthieng, Somchet (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 89p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The transient analysis of transistorized logarithmic amplifiers employing a transistor as the logarithmic conversion and feedback element is presented. The variation of the log-transistor parameters are studied with respect to various levels of collector current, and the effects of these parameters on the oscillation stability of the amplifier are examined. This information is used to formulate the theoretical equations describing the transient behavior. (W.H.K.)

38146 (ORNL-TM-2212) COMPUTER PLOTTING OF DATA FROM THE MOBILE AMPHIBIOUS DETECTION SYSTEM USED IN RADIOACTIVE ISOTOPE SAND TRACER STUDIES. Brashear, H. R.; Simpson, R. L.; Acree, E. H.; Case, F. N.; Cutshall, N. H.; Johns, J. C. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

A computer program has been written for determining the plotting position, time, and count rate of sand tagged with ^{133}Xe which has been deposited in a littoral system. The determination of actual data plots and evaluation of the results are discussed. It is seen that method changes are needed in search patterns, placement of range-finding equipment, location of injection site, and rate of data reduction during future experiments. (auth)

38147 (UCID-15336) FIDUCIAL DISTRIBUTION SYSTEM. Altbaum, Laurence P. (California Univ., Livermore. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 18p. Dep. CFSTI.

The LRL fiducial distribution system, which was designed to provide an accurate signal for data collection systems so that all the experiments tied to an event will have a common time-reference point, is described. System components and characteristics, user responsibilities and procedures, and system timing information are discussed. (W.H.K.)

38148 (UCID-15343) RUCKER SAFETY SENTRY EVALUATION MODEL 103 (PORTABLE). Downs, D. C. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 27, 1968. Contract W-7405-eng-48. 4p. Dep. CFSTI.

The Rucker Model 103 Safety Sentry designed to give protection to the operator of a line operated piece of equipment is described. If the operator should come in contact with the hot wire of the line while at the same time grounded the device would remove power from the equipment in use. (B.G.D.)

38149 (UCRL-13344) [FISSION PRODUCT ANALYSIS]. Final (Letter) Report. Herzog, Leonard F. (Nuclide Corp., State College, Pa.). Jan. 13, 1968. Contracts W-7405-eng-48; 6920103. 7p. Dep. CFSTI.

For Univ. of California, Lawrence Radiation Lab., Livermore.

The development of capillary tubes for ion transport, experiments with drift tubes, and development of a mass spectrometer for fission product analysis are briefly described. (W.H.K.)

38150 (UCRL-17989, pp 167-79) MASS SPECTROSCOPY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Topics discussed include autoionization of highly excited Ar^+ ions produced by electron impact, operation of an ultrahigh-vacuum molecular beam apparatus for studies on excited states of molecules, a photomultiplier for the detection of metastable electronically excited molecules, and time-of-flight resolution of electronically excited molecules. (W.H.K.)

38151 (UCRL-18031) PHOTOMULTIPLIER SHIELD AND BASE SYSTEM. Parker, Sherwood; Oliver, William; Rey, Charles (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 11, 1968. Contract W-7405-eng-48. 8p. Dep. CFSTI.

A photomultiplier shield and base system are described with simple construction, complete electrical shielding suitable for use near large spark chambers, quick access, and magnetic shield length optimized for axial fields. (W.H.K.)

38152 (UCRL-71084) REGULATED MAGNETIC BURST GENERATOR. Aaland, Kristian; Westbrook, Edwin P. (California Univ., Livermore. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 20p. (CONF-680520-2). Dep. CFSTI.

From 10th Modulator Symposium, New York.

A description is given of a 20-kW peak power pulse generator, used in a group of twenty generators supplying pulses to an array of instrumentation sensors at a combined pulse rate of 4 MHz. Pulse requirements per generator are: bi-polar, 0.2 microsecond duration, triggered at rates up to 200 kHz, one-shot 30-millisecond burst, amplitude constant to 0.1% from pulse-to-pulse. A push-pull, switching core, 1:20 step-up transformer is driven from 150 V dc by high speed, high voltage, switching transistors operated in current-sharing parallel-connected groups. Negative feedback maintains constant current charging of a pulse forming network (PFN) on the secondary, during the approximately 3 microseconds to core saturation, after which the PFN discharges into a 50-ohm output cable, using the secondary winding saturated inductance as a portion of the PFN. (auth)

38153 TIME ANALYZER USING BINARY SCALERS. Hasegawa, Ken-ichi (Tokyo Univ.); Komorida, Katsuhiro; Nishino, Osamu; Sekiguchi, Akira. Nippon Genshiryoku Gakkaishi, 10: 313-18(1968). (In Japanese).

A 32 channel time analyzer utilizing binary scalers for storage has been developed, which is capable of performing completely automatic data readout, both in precision analog and digital forms. The purpose of this analyzer is to measure neutron time distributions in pulsed neutron experiments for nuclear engineering. The data stored in the scalers are read out nondestructively, so that the data can be displayed in the form of histograms on a cathode-ray tube both during and after measurements. Another advantage of the analyzer is its small dead time, compared to similar instruments using core memories. A method is also presented for data readout from integrated circuits used as a binary scaler. (auth)

38154 NEW CZECHOSLOVAK PHOTOMULTIPLIER FOR NUCLEAR INSTRUMENTS. Stratonov, Oleg; Beranek, Ivan (Scientific-Research Inst. of Vacuum Electronics, Prague). Jad. Energ., 14: 233-8(July 1968). (In Czech).

Seven new types of photoelectron multipliers used in Czechoslovakian laboratories are described. Five types of photomultipliers operate with antimony-cesium cathodes and two with multialkali cathodes. One of the first five is supplied by a controlling screen while the other four have an ordinary construction. The largest multialkali multiplier has jalousie type dynodes. Photomultipliers are designed for operations in nuclear physics and technology and have resolving power of 7 to 13%. Technological specifications of multipliers are included. (tr-auth)

38155 INSTALLATION FOR THE MEASUREMENT OF THE ELECTRIC CONDUCTIVITY AND THERMOELECTROMOTIVE FORCE OF RADIOACTIVE CATALYSTS. Spitsyn, V. I.; Erofeev, B. V.; Kozhenov, K. S.; Mikhailenko, I. E. (Inst. of Physical Chemistry, Moscow). Kinet. Kataliz, 9: 456-8(Mar.-Apr. 1968). (In Russian).

A device, used to measure resistance from 10^{-3} to 10^{12} ohm and thermoelectric force of radioactive solid catalysts in vacuum or in atmosphere of gas, necessary for a given experiment, was constructed. The device was designed for measurement of polycrystalline solids, compressed in the form of tablets or polished bars. (tr-auth)

38156 TWO-SIDED COUPLING OF A MEASUREMENT CENTER WITH A COMPUTER. Zabiyakin, G. I.; Zamrii, V. N.; Nefed'eva, L. S.; Ostanevich, Yu. M.; Yagafarova, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 78-82(Mar.-Apr. 1968). (In Russian).

The characteristics of the two-sided coupling system of the JINR measurement center with the Minsk-2 computer were examined. The following coupling regimes were realized: (a) transmission of the results of the measurement from multichannel measurement systems and storage of these data in the computer; (b) transmission, operative processing of the data from the experimental program, and input of the processing in the buffered memory installation of the center; (c) transmission of criteria given the experimenter, search of data in the computer on these criteria, and recovery of the required data from the computer. (tr-auth)

38157 INSTALLATION FOR THE EXCHANGE OF EXPERIMENTAL DATA WITH A COMPUTER. Vladimirov, V. A.; Duda, F.; Zamrii, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 83-91(Mar.-Apr. 1968). (In Russian).

An installation was described that is used (a) to transmit to the Minsk-2 computer data from the measurement system (buffered memory installation with 4096 numbers) and supplementary data (on the coupling regime, processing program, etc.), composed on the keyboard; (b) to receive from the computer in the buffered installation the results of data processing or other data; and (c) to copy data from the measurement system in the buffered installation. The transmission and intake are controlled and repeated, if necessary, automatically. The experimenter obtains data on the accuracy of the data exchange. (tr-auth)

38158 SCHEME FOR THE REGISTRATION OF PULSES FROM A PHOTOMULTIPLIER TUBE. Vovchenko, V. G.; Zheleznyakov, V. M. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 2, 95-9(Mar.-Apr. 1968). (In Russian).

A complex circuit with short dead time for the registration of nanosecond pulses was described. A coincidence-anticoincidence circuit, an amplifier-discriminator circuit, and a weak signal amplifying circuit are included in the total circuit. The circuits were used for the registration of pulses from a photomultiplier tube during measurements on a proton beam with energy from 400 to 600 MeV. All circuits were developed from semiconductor elements. (tr-auth)

38159 TIME-TO-AMPLITUDE CONVERTER IN THE NANOSECOND RANGE. Efimchik, M. K.; Zaitseva, A. M.; Chernyavskii, A. F. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 2, 102-5(Mar.-Apr. 1968). (In Russian).

A high-speed circuit for a time-to-amplitude converter with formation and separation of photomultiplier signals was described. The converter was developed using semiconductor devices and designed for work in the nanosecond range. (tr-auth)

38160 CURRENT INTEGRATOR WITH CONTROLLABLE ELECTRON VALVE. Afanas'ev, N. G.; Denyak, V. M.; Startsev, V. I.; Pal'-Val, P. P. Prib. Tekh. Eksp., No. 2, 117-19(Mar.-Apr. 1968). (In Russian).

An integrator circuit, used to measure currents at 10^{-7} to 10^{-12} A without switching of the range, was described. It has a precision of ±1% and linearity not below 2%. The construction of such a circuit shows the possible use of vacuum tubes with high internal resistance as switches and proportional elements. The integrator circuit was designed for measurement of the current of a beam of high-energy electrons in the linear accelerator. (tr-auth)

38161 FOUR-CHANNEL HIGH VOLTAGE SOURCE WITH STABILIZATION AND ADJUSTMENT IN THE RANGE FROM 5 TO 25 kV. Glagoleva, N. S.; Matyushin, A. T.; Matyushin, V. T.; Firkovskii, R.; Khachaturyan, M. N.; Chuvilo, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 2, 148-9(Mar.-Apr. 1968). (In Russian).

A four-channel high voltage source with stabilization and adjustment in the range from 5 to 25 kV was described. The adjustment and stabilization with coefficients of ~100 are accomplished independently of each channel. The maximum load current of one channel is 0.5 mamp. The energy consumption from the source can be regular or pulse. The source was used in an installation with a spark chamber. (tr-auth)

38162 PULSE GAS-DISCHARGE COMMUTATING DEVICE WITH RADIOACTIVE STABILIZATION OF THE BREAKDOWN POTENTIAL. Lobov, S. I.; Tsukerman, V. A.; Zykov, A. P.; Kanunov, M. A.; Pavlovskaya, N. G. Prib. Tekh. Eksp., No. 2, 167-9(Mar.-Apr. 1968). (In Russian).

Two- and three-electrode gas filled dischargers for commutation of current pulses in the voltage range from 0.5 to 15 kV were described. The stabilization of the breakdown potential of the gas discharge gap was accomplished by means of β particles emitted by titanium–tritium sources. (tr-auth)

38163 X-RAY CHAMBER FOR PRODUCTION OF X-RAY PHOTOGRAPHS AT LARGE AND SMALL ANGLES. Gerasimov, V. I.; Tsvankin, D. Ya. (Inst. of Elemental-Organic Compounds, Moscow). Prib. Tekh. Eksp., No. 2, 204-5(Mar.-Apr. 1968). (In Russian).

The construction of a chamber for the production of x-ray photographs at large and small angles was described. The vacuum chamber can work with any x-ray apparatus. The alignment of the diaphragm and trap of the primary beam were done by means of a simple optical arrangement. (tr-auth)

38164 FLOW MEASURING DEVICES. O'Halloran, Oliver Finbar Barry; Pugh, Derrick Owen (to English Electric Co. Ltd.). British Patent 1,118,802. July 3, 1968. Filed Dec. 22, 1964.

A flow-measuring device for measuring very small intermittent or continuous mass flow rates of nongaseous substances is described. Two buckets are mounted on a horizontal axis so that when one is filled by a predetermined mass the system pivots to dump the full bucket and reposition the empty bucket. Revolutions of the buckets are counted to determine mass flow. The system is used for measuring the mass flow of condensate from carbon dioxide coolant-gas dryers associated with gas-cooled reactors. (W.H.K.)

38165 ULTRASTABLE EDDY CURRENT NONDESTRUCTIVE TESTING APPARATUS. Green, Donald R. (to United States Atomic Energy Commission). U. S. Patent 3,394,304. July 23, 1968.

An ultrastable eddy current nondestructive testing device capable of detecting resistivity changes in Zircaloy-2 of .4% above the normal resistivity is described. A first probe coil is mounted adjacent a test sample and a second like probe coil is mounted adjacent a reference sample. The first and second probe coils are connected to form adjacent arms of a first bridge circuit. A second bridge circuit is used, with the first and second bridge circuits being initially adjusted to give equal amplitude outputs. Both bridge circuits are driven from a common oscillator. Means are provided for alternately connecting the outputs of the bridge circuits to the input of an amplifier and for converting the output of the amplifier to a D–C signal. First and second capacitors are provided. Means synchronized with the output alternately connecting means are provided for applying the D– C output signal from the converting means derived from the output of the first bridge circuit to the first capacitor to cause charging thereof. Means are also provided synchronized with the output alternately connecting means for applying the D–C output signal from said converting means derived from the output of the second bridge circuit to the second capacitor to cause changing thereof. Means are provided for differentially measuring the charge on the capacitors. (AEC)

38166 TOROIDAL EDDY CURRENT NONDESTRUCTIVE TESTING PROBE. Brown, Russell L. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,395,339. July 30, 1968.

A toroidal eddy current probe is described for use with a conventional eddy current nondestructive testing device. The toroidal probe includes a plurality of encircling coils mounted to form a toroid whose annulus is sized to pass a sample therethrough. Each of the encirculing coils is positioned such that the windings are substantially parallel to the direction of motion of the sample through the annulus of the toroid formed by the encircling coils. Each of the encircling coils is serially connected. (AEC)

38167 MODERN OPTICS. Proceedings of the Symposium held in New York, N. Y., March 22–24, 1967. Fox, Jerome (ed.). Microwave Research Institute Symposia Series. Volume XVII. Brooklyn, Polytechnic Press of the Polytechnic Institute of Brooklyn, 1967. 837p. (CONF-670333).

One of the 58 papers presented is abstracted and included in NSA. The other 57 papers are not within the scope of NSA. (W.H.K.)

For an abstract of the individual paper see: 38091.

38168 SEAL. Tanzberger, E. W. (to United States Atomic Energy Commission). U. S. Patent 3,392,910. July 16, 1968.

An improved seal between relatively rotating parts is described which is effective against the escape of fluid through an opening in apparatus including a casing providing a chamber in which relatively high pressure fluid may be confined and having such opening through which a rotary member extends. (AEC)

38169 HIGH SPEED AMPLIFIER-DISCRIMINATOR WITH WIDE DYNAMIC RANGE. Sawada, Fred H. (to United States Atomic Energy Commission). U. S. Patent 3,395,294. July 30, 1968.

A high frequency pulse amplifier having a wide dynamic amplitude range is described. The output from a differentiator-clipper combination provides an input to the base of an emitter-follower having its base-emitter circuit normally heavily conducting at unity gain. A tunnel diode connected to the output of the pulse amplifier is biased to provide narrow pulses in response to input pulses which exceed a predetermined value. (AEC)

38170 QUADRUPOLE MAGNET WITH REDUCED FIELD DISTORTION. Danby, G. T.; Jackson, J. W. (to United States Atomic Energy Commission). U. S. Patent 3,393,385. July 16, 1968.

A quadrupole magnet in which harmonic effects are reduced by providing stepped protrusions on the pole faces is described. The protrusions which minimize distortion in this magnetic field are symmetrical and integral with the pole faces. (AEC)

38171 MASS SPECTROMETER UTILIZING AN ION BEAM FOR IONIZING THE GAS TO BE ANALYZED. Friedman, L.; Moran, T. F.; Leventhal, J. J. (to United States Atomic Energy Commission). U. S. Patent 3,392,280. July 9, 1968.

The method and apparatus for mass spectral analysis utilizing an external beam of low velocity ions for ionizing the species under investigation are described. Because of the low velocities employed there is less alteration of molecular structure so that the invention is capable of distinguishing between isomers of the same molecules even when such is not readily accomplished when conventional electron beams are used. (AEC)

38172 ION SOURCE HAVING A HOLLOW CYLINDRICAL PERMANENT MAGNET MAINTAINED AT A POSITIVE POTENTIAL RELATIVE TO THE ELECTRON EMITTER. Davis, William D. (to General Electric Co.). U. S. Patent 3,385,965. May 28, 1968. Filed Aug. 10, 1965.

A mass spectrometer ion source for highly efficient production of ions at very low pressures having substantially no energy spread utilizing a magnetic field to enhance ionization is described. Electrons emitted from a hairpin filament situated within the interior of a hollow cylindrical permanent magnet are constrained by electric fields to remain within the interior of the magnet and thereby increase the probability of collisions with gas molecules. (U. S. Pat. Gazette)

38173 MEASUREMENT AND CONTROL OF MAGNETIC FIELD HOMOGENEITY. Ernst, Richard R. (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instrum., 39: 998-1012(July 1968).

Methods for the measurement and control of magnetic field homogeneity are described. They are designed for application in magnetic resonance spectroscopy. It is shown that field homogeneity can be described satisfactorily by properties of the observed spectral line shape only. Possible criteria include the moments, peak height, and signal energy of a typical resonance line. The moments are equivalent to the L_p norm of the magnetic field configuration. Only the second moment and related criteria allow the construction of a complete set of noninteracting shims which can be adjusted independently for any field configuration. The other moments may provide noninteracting control for certain simple field configurations only. For a resonance line with a sufficient natural width, peak height, and energy can be related to the second moment and may also give noninteracting control. Iterative methods for automatic control by means of digital computers are described and applied to a high resolution nuclear magnetic resonance spectrometer. (auth)

38174 PICTORIAL PATTERN RECOGNITION. Proceedings of Symposium on Automatic Photointerpretation, Washington, D. C., May 31–June 2, 1967. Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Company, 1968. 530p. (CONF-670541).

Separate abstracts were prepared for 5 of the 28 papers presented. The remaining 23 papers were not sufficiently within the scope of NSA to be included. (W.H.K.)

For abstracts of individual papers see: 38092–38095 and 38351.

38175 RANDOM PULSE GENERATOR WITH SEMICONDUCTOR DETECTOR OF ALPHA RADIATION AND INTEGRATED CIRCUIT. Pesic, Ljutica; Jankovic, Tihomir; Boberic, Hans (Electroinstitute, Belgrade). Tehnika (Belgrade), 23: No. 1, 84-7(Jan. 1968). (In Slavic).

A simplified and improved design is given of a pulse generator previously described by Lj. Pešic et al. (Naučno Tehnički Pregled No. 9, 1967) with transistorized amplifier, discrete component parts, and integrated circuits. Measurements were made of pulse distribution as a function of the time interval frequency, generator operation temperature, compensation probability and mean pulse frequency. Measurements were made of α-particle arbitrary pulses using ^{239}Pu isotope. The measured distribution of arbitrary pulses showed that at a mean frequency of 200 mp/sec the distribution is of the Poisson type in the measured range of 0.1 sec is same as the Gaussian type in the same range. (R.V.J.)

38176 ELECTRON MULTIPLIER PULSE-HEIGHT DISTRIBUTIONS. Wright, W. H. (Southwest Center for Advanced Studies, Dallas). J. Appl. Phys., 39: 3492-5(June 1968).

The pulse-height distribution of a 12-stage AgMg box-and-grid multiplier was obtained using a charge-sensitive amplifier with a variable discriminator. Integral bias curves were measured and then differentiated to yield the distribution. The amplifier and discriminator were calibrated, and theoretical and experimental pulse-height distributions for an electron multiplier are presented graphically. (W.H.K.)

38177 WIDEBAND LOGARITHMIC INTEGRATING ELECTROMETER FOR RECORDING WEAK CHARGED-PARTICLE FLUXES. Gadalov, A. N. (Moscow State Univ). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 864-7(1967).

Translated from Geomagn. Aeron., 7: 1066-70(1967).

A transistorized logarithmic integrating electrometer for measuring weak charged-particle fluxes is described. The lowest current measured is 1.1×10^{-15}a and the dynamic range is 10^4. The sign of the charge is determined from the sign of the first half-wave of the sine wave. The power consumption of the electrometer is 50 mw. (auth)

38178 VERSATILE "MONOENERGETIC" ELECTRON IMPACT SPECTROMETER FOR THE STUDY OF INELASTIC COLLISION PROCESSES. Brion, C. E.; Thomas, G. E. (Univ. of British Columbia, Vancouver). J. Mass Spectrom, Ion Phys., 1: 25-39 (Apr. 1968).

The construction and operation of a monoenergetic electron impact spectrometer employing a monopole mass analyzer is described. Results are given for a wide variety of inelastic collision processes. (auth)

38179 A 15-cm RADIUS MASS SPECTROMETER WHICH SIMULTANEOUSLY COLLECTS POSITIVE AND NEGATIVE IONS. Svec, Harry J.; Flesch, Gerald D. (Ames Lab., Iowa). J. Mass Spectrom. Ion Phys., 1: 41-52(Apr. 1968). (IS-1767).

A mass spectrometer which simultaneously extracts positive and negative ions from a single electron beam is described. Its features include ready accessibility to the ion source and collectors, convenient attainment of alignment, simultaneous display of positive and negative ion spectra, and direct plotting of ionization efficiency data. (auth)

38180 INFRARED DETECTION OF RADIOISOTOPE HEAT SOURCES. Perkins, D. R.; Hedgepeth, L. M. pp 187-93 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

An experimental effort to determine the feasibility of using an airborne infrared detection system to locate radioisotope heat sources after a mission abort or reentry is described. An aircraft equipped with an infrared detector optimized for 2°C sensitivity at ambient conditions was used for the tests. Two electrically heated sources were devised to simulate radioisotope sources—a small capsule source and a large plate source. The sources were placed in three types of locations—in the open, under heavy foliage, and buried in sand. No difficulty was experienced in locating the sources under all three conditions from an altitude of 10,000 feet under clear skies. Tests proved that the use of infrared detection equipment is feasibile in locating radioisotope sources, although the equipment was not optimized for this purpose. Recommendations are included for improving the detectors and the sources to enhance detectability. (auth)

38181 METHOD FOR REDUCTION OF VARIATION OF THE LINEAR DIFFERENTIAL BY THE ANALOG-DIGITAL CONVERSION ACCORDING TO THE PRINCIPLE OF GRADUAL APPROXIMATION. Schuster, H.-J. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 63: 182-4(Aug. 1968). (In German).

An improved method for the conversion of an analog voltage to a digital number is described. (auth)

38182 MOESSBAUER EFFECT METHODOLOGY IN AEROSPACE APPLICATIONS. Gruverman, I. J. (New England Nuclear Corp., Boston). pp 80-6 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

A survey of the utilization of the Moessbauer effect in aerospace technology is presented. Analytical applications of the Moessbauer effect, techniques for applying the scattering concept, and an explanation of the principles of the non-dispersive analyzer were included. (W.H.K.)

38183 TUNNEL DIODE: TRANSISTOR RING COUNTER. Tan, Z. C.; Maxwell, P. C. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods, 63: 230-2(Aug. 1968).

Comments on a proposed ring counter are presented, and an improved circuit which employs a series feedback transistor is described. (W.H.K.)

38184 A MONOCHROMATOR SYSTEM FOR THE IRRADIATION OF BIOLOGICAL MATERIAL, UTILIZING INTERFERENCE FILTERS AND AN ELECTRONICALLY CONTROLLED 2.5-KW XENON ARC. Raschke, Klaus (Univ., Giessen, Ger.). Planta, 75: 55-72(1967). (In German).

A high pressure xenon arc lamp XBO 2500 W was used as a radiation source for the production of quantum fluxes of the order of 6 μEinstein/sec at λ = 700 nm and 2 μEinstein/sec at λ = 400 nm. Wavelength selection between 300 and 900 nm was made by tandem interference filters of the band pass type (band width at half peak transmission approximately 16 nm), with a total transmission outside of passband < 0.08%. The radiation load on the filters was reduced by the use of interchangeable selective mirrors. The front surface of the interference filters was cooled with de-ionized water (metal interference filters absorb more than 30% of the impinging visible radiation). Homogeneity of irradiance was achieved by a honeycomb condensor. A simple cascaded feedback system sensitive to changes in lamp current and irradiance kept radiation intensity constant with time. Technical details, including safety devices, were given. (BBB)

38185 TWO-CRYSTAL X-RAY INTERFEROMETER. Bonse, U.; te Kaat, E. (Univ., Muenster, Ger.). Z. Phys., 214: 16-21 (1968).

The construction and successful operation of an X-ray interferometer consisting of two separate crystals are described. Alignment is made with the help of three X-ray beams that are multiply reflected by both crystals. The crystal lattice moire pattern is photographed. Its fringe distance may be altered in a defined way by tilting one crystal with respect to the other. The pattern shows a spontaneous drift corresponding to a shift of about 0.2 Angstrom units per minute of one crystal relative to the other. It is possible to superimpose a given shift velocity in either direction. The traveling pattern is registered with a counter and relative displacements of the crystals as small as 0.2 Angstrom units can be measured. (auth)

Radiation Effects on Instruments and Instrument Components

38186 (N-68-11469) ANALYSIS OF RADIATION DAMAGE TO ATM FILM. Shelton, Russell D.; de Loach, A. C. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Oct. 20, 1967. 30p. (NASA-TM-X-53666). CFSTI.

Potential radiation damage to Apollo Telescope Mount (ATM) photographic film is analyzed in view of the fact that they will be subjected to a proton flux during the mission. Proton dose rates are calculated as functions of orbital inclination, altitude, and shielding thickness; film sensitivities of proton radiation are determined experimentally. Film darkening is then expressed as a function of elapsed time in orbit. It is concluded that several ATM films would not survive the radiation environment; research and test programs are underway to provide substitute emulsions which can be protected with a modest shielding requirement. (auth) (STAR)

38187 (N-68-19924) EFFECTS OF 22-MeV PROTON AND 2.4-MeV ELECTRON RADIATION ON BORON AND ALUMINUM-DOPED SILICON SOLAR CELLS. Haynes, Gilbert A.; Ellis, Walter E. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Apr. 1968. 67p. (NASA-TN-D-4407). CFSTI.

A comparative analysis is presented of the effects of proton and electron irradiation on the electrical properties of boron-doped and aluminum-doped, n on p, silicon solar cells having base resistivities of 1 ohm-cm and 10 ohm-cm. Electrical measurements were made before and after irradiation at various flux levels up to 2.1×10^{12} protons per square centimeter at 22 MeV, and 1.0×10^{16} electrons per square centimeter at 2.4 MeV. Measurements of short-circuit current and maximum power under illumination with a tungsten light source and a solar simulator indicate that 1 ohm-cm aluminum-doped cells are slightly more resistant to damage by 2.4 MeV electrons than 1 ohm-cm boron-doped cells; however, 10 ohm-cm boron-doped cells were found to be more resistant to electron damage than 10 ohm-cm aluminum-doped cells. Spectral response measurements made before and after irradiation indicated no significant difference due to the type of doping element employed. From these spectral response curves, conversion factors were computed for use in predicting the output of solar cells in space sunlight from direct measurements under tungsten light or the solar simulator. (auth) (STAR)

38188 AN INVESTIGATION OF THE EFFECTS OF ELECTRON IRRADIATION ON THE METAL/OXIDE/SEMICONDUCTOR SYSTEM. MacDonald, Noel Charles. Berkeley, Calif., Univ. of California, 1967. 158p.

Thesis.

Both transient and steady-state changes in the electrical characteristics of metal-oxide-semiconductor transistors (MOST's) produced by localized electron-beam bombardment are reported here. Typically, areas 10 μm × 10 μm were bombarded on the gate of the MOST by scanning a 0.1 μm diameter electron beam over this area. The electron-beam energy was variable from 5 to 30 keV, the beam current was varied from 1 to 300 pA, and the time to scan one frame was typically 8 msec. During bombardment with positive gate voltage V_{GB}, the negative charge in the MOST channel induced by bombardment Q_S' was found to increase which implied that a fixed positive charge Q_{SS} builds up in the oxide during bombardment. Q_S' reached a steady-state, or saturated value, $Q_S'(SAT)$, after a total primary electron-beam bombardment of approximately 10^{-5} C/cm^2. A linear relationship between $Q_S'(SAT)$ and the gate voltage during bombardment V_{GB} was observed for both n-channel and p-channel devices, for $0 < V_{GB} < 3.6$ V. A theory is developed which explains electron-beam-induced charge-storage effects observed in metal-oxide-semiconductor structures. A steady-state charge distribution is derived, based on a constant density of traps/unit energy, K_t, in the forbidden region of the oxide. This steady-state-induced charge density decreases exponentially from the oxide-semiconductor interface with a characteristic length $x_1 = (\epsilon_{0x}/q^2K_t)^{1/2}$, and predicts the observed linear relationship between the steady-state field at the oxide-semiconductor interface and the gate voltage during bombardment V_{GB}. A sheet-charge transient analysis of the charge-transport phenomena in the oxide under electron-beam bombardment is also developed. This analysis has two parameters, x_1 and τ_c, where the charging time constant τ_c is independent of V_{GB}, and depends only on the energy loss/unit distance of the primary electron beam in the oxide. Most aspects of this analysis are verified by detailed experiments. Applications of the charge storage phenomena to electron beam information storage are described. An electron-beam-activated switch (EBAS) is proposed; then the characteristics of the EBAS are discussed. Memory configurations that use an array of EBAS's are also considered. (Diss. Abstr.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 37652, 38000, 38259, 38264, 38292, 38302, 38329, 38334, 38336, 38378, 38407, 38426, 38427, 38429, 38433, 38443, 38458, 38473, 38491, and 38499.

38189 (BNL-12300) INFLUENCE OF EXTRACORPOREAL IRRADIATION OF THE BLOOD AND LYMPH ON LYMPHOPOIESIS AND IMMUNITY. Cronkite, Eugene P.; Chanana, Arjun D.; Joel, Darrel D.; Rai, Kanti R.; Schiffer, Lewis M. (Brookhaven National Lab., Upton, N. Y.). Mar. 25, 1968. 25p. (CONF-680413-1). Dep. CFSTI.

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco.

The theoretical and practical aspects of extracorporeal irradiation of blood and lymph are reviewed. The following studies are included: size of intravascular and extravascular pools of lymphocytes; average time spent by lymphocytes in blood; rate of mobilization of lymphocytes from tissue; lymphocyte production rates; function of lymphocytes; comparison of preceding variables in leukemic and normal animals of the same species; factors controlling lymphopoiesis; role of the lymphocyte in immunologic processes; and as a possible adjunct to aid in the allotransplantation of tissues and organs. This technique is extremely useful in delineating basic lymphocyte physiology and immunology and is a powerful tool for the investigation, either alone or in conjunction with cell labeling studies, of normal and leukemic kinetics. (H.L.W.)

38190 (CEA-R-3012) CONTRIBUTION A L'ETUDE DU FIBRINOGENE ET DE LA SERUM-ALBUMINE PLASMATIQUES EFFETS DE L'IRRADIATION. (Contribution to the Study of Plasmatic Fibrinogen and Serum Albumin: Effects of Irradiation). Suscillon, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 119p. (In French). Dep.

Thesis. Submitted to Grenoble Univ., France.

Effects of low-energy x rays on properties and structure of serum albumin and fibrinogen were studied. A technique for amperometric determination of the fibrin stabilizing factor is presented. The kinetics of fibrin formation was studied by means of spectrophotometry. Platelet fibrinogen was demonstrated and determined quantitatively. (H.L.W.)

38191 (DP-MS-66-88) EFFECTS OF TEMPERATURE ON THE SORPTION OF RADIONUCLIDES BY A BLUE-GREEN ALGA. Harvey, R. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 19, 1967. Contract AT(07-2)-1. 15p. (CONF-670503-29). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Environmental factors affecting the sorption of radionuclides by fresh-water species of diatoms, green, and blue-green algae are being investigated at the Savannah River Laboratory to determine the role of algae in the fate of radionuclides released to the reactor effluent streams. Because the temperatures of these streams are affected by reactor operations and seasonal changes, the effects of nonlethal changes in water temperature on growth and the sorption of radionuclides by algae are of particular interest. Effects of a 15°C temperature differential on the sorption of ^{137}Cs, ^{85}Sr, ^{65}Zn, ^{59}Fe, ^{57}Co, and ^{54}Mn by the filamentous blue-green alga, Plectonema boryanum, are reported in this paper. The sorption pattern for ^{57}Co differed from all others in that concentrations per gram of algae were highest at 25°C and decreased with temperature up to 40°C. The concentrations of ^{54}Mn increased with temperature up to 35°C. There was no positive correlation between water temperatures and sorption levels for ^{65}Zn, ^{59}Fe, ^{85}Sr, and ^{137}Cs although the concentration of each radionuclide was slightly higher at 40°C than at lower temperatures. (auth)

38192 (EUR-3607) APPLICATIONS RADIOBIOLOGIQUES DE LA PHYSIOLOGIE CELLULAIRE. RAPPORT FINAL, 1961-1966. (Radiobiological Applications of Cellular Physiology. Final Report, 1961-1966). (Brussels Univ. (Belgium)). Dec. 1967. Contract 007-61-10 BIAB. 138p. (In French). Dep.

A coordinated effort was carried out to analyze the mechanisms controlling protein synthesis in biological systems of growing complexity: bacteriophages, bacteria, unicellular algae (Acetabularia), the egg in the various stages of its development differentiated or cancerous cells, the adult mammal. Genetic, biochemical, biophysical, and cytochemical methods were combined to achieve this end. The results obtained should form a useful basis for the study of the effects of radiation at molecular level. (auth)

38193 (EUR-3912) REPORT OF ACTIVITIES OF THE INTERNATIONAL LABORATORY OF GENETICS AND BIOPHYSICS, JANUARY 1-DECEMBER 31, 1966. (International Lab. of Genetics and Biophysics, Naples (Italy)). Aug. 16, 1967. 106p. Dep.

BACTERIOPHAGES — alpha, chronological maps of genomes of, comparison of, with genetic maps; T4, effects on metabolism in host bacteria; lambda, effects on metabolism in host bacteria; lambda, genetic maps of

GAMMA RADIATION — effects on synthesis of RNA on templates of bacteriophage DNA

SCHIZOMYCOTA — Escherichia coli, synthesis of RNA in, effects of bacteriophage infections on; Samonella typhimurium, reproduction of bacteriophages in; Escherichia coli, content of ribosomes in, isolation and determination of properties of

ECHINODERMATA — Arbacia lixula, development of embryos of, characteristics of DNA during; Arbacia sp., protein synthesis during development of eggs of

ULTRAVIOLET RADIATION — effects on activity of lysozyme in lambda bacteriophages; effects on reproduction of lysogenic bacteriophages in Escherichia coli

MAN — genetic drift in populations of

CELLS — differentiation and growth of cultured mammalian, effects of enzymes and genetics on; transformation of cultured hamster, by polyoma viruses

EUGLENOPHYTA — Euglena gracilis, synthesis of aldolases in

PROTEINS — analysis of ribosome, isolated from tissues of mammals

BRAIN — synthesis of RNA in, of rabbits (C.H.)

38194 (EUR-3917) MOUVEMENT DE CERTAINS ISOTOPES CHEZ LES ANIMAUX ET CHEZ L'HOMME. RAPPORT ANNUEL 1965. (Movement of Certain Isotopes in Animals and in Man. Annual Report, 1965). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1968. 56p. (In French). Dep.

The research work carried out in 1965 served to reveal the broad outline of the metabolism of elements that are hydrolyzed at the pH of living matter; the differences between this metabolism and that of natural elements can be accounted for by physical chemistry. The studies were conducted with cerium-144 and plutonium-239, used in the form of dissociated salts, complexes, and even colloids. The metabolic studies were accompanied by experiments concerned more particularly with the therapeutics of internal contamination by plutonium or rare earths. (auth)

38195 (NYO-3515-3) PROGRESS REPORT [ON TRACE LABELING OF PROTEINS]. [Hofer, Kurt; Rosenoff, Stephen; Hughes, Walter L.] (Tufts Univ., Boston, Mass. School of Medicine). June 19, 1968. Contract AT(30-1)-3515. 18p. Dep. CFSTI.

The use of ^{51}Cr for tracing the transport of proteins was investigated. Procedures were developed for labeling proteins with chromous ions, preparing radioactive chromous ions, and determining the valence state of radioactive chromium. The use of chromium as a label for living tumor cells was reevaluated and found not to be as effective as the DNA label, iododeoxyuridine. A new method of labeling proteins with iodine at very high specific activities was developed. Labeled ribonuclease was purified and characterized. The fate of iodine-labeled ribonuclease in mouse kidney was investigated with the discovery that absorbed ribonuclease was contained in at least two types of particles readily separable on sucrose gradients. Studies on the transport and distribution of chromium in the body showed that the hexa-aquo chromic ion binds to transferrin. (auth)

38196 (ORO-3635-1) SERINE METABOLISM IN RADIATION CHIMERAS. Kretchmar, A. L. (Tennessee Univ., Knoxville). [1967]. Contract AT(40-1)-3635. 2p. (CONF-670440-1). Dep. CFSTI.

From Bone Marrow Round-Table Conference, Chicago, Ill.

Lethally irradiated mice were given homologous bone marrow cells; controls consisted of unirradiated normal mice and lethally irradiated mice given isologous cells. Carbon-14-labeled serine was injected intraperitoneally, and the mice were placed in a small glass chamber. The ^{14}C in the exhaled carbon dioxide was measured by pumping the exhaled air through an ionization chamber.

The specific activity of the respiratory carbon dioxide was much higher in the homologous chimeras than in the control mice. Injection of glucose with serine produced no effect on the specific activity; glycine with serine caused a decrease in specific activity; and formate with serine caused an increase in specific activity. (H.L.W.)

38197 (ORO-3635-2) SERINE METABOLISM IN RADIATION CHIMERAS. Kretchmar, A. L.; Congdon, C. C. (Tennessee Univ., Knoxville). 1967. Contract AT(40-1)-3635. 2p. (CONF-670642-2). Dep. CFSTI.

From 1st International Conference on Organ Transplantation and Bone Marrow, Paris, France.

Lethally irradiated mice were given homologous bone marrow cells; controls consisted of unirradiated normal mice and lethally irradiated mice given isologous cells. Carbon-14-labeled serine was injected intraperitoneally, and the mice were placed in a small glass chamber. The ^{14}C in the exhaled carbon dioxide was measured by pumping the exhaled air through an ionization chamber. The specific activity of the respiratory carbon dioxide was much higher in the homologous chimeras than in the control mice. Injection of glucose with serine produced no effect on the specific activity; glycine with serine caused a decrease in specific activity; and formate with serine caused an increase in specific activity. Results of these experiments are reported in ORO-3635-1. (H.L.W.)

38198 (UCRL-18140, pp 159-73) THE DEPOSITION OF ^{226}Ra AND ^{210}Pb IN THE HUMAN AORTA. Cohen, Norman (New York Univ. Medical Center).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

The ^{226}Ra and ^{210}Pb contents of various soft tissues from two former radium dial painters were measured to determine the distribution and concentration levels of these nuclides in the organs of exposed individuals. In both cases, the aorta contained significantly higher concentrations of radium and lead than were present in other tissues. The significance of this finding is discussed with reference to normal values, concentration mechanism, radiosensitivity of the aortic wall, and a preliminary estimation of α dose. (auth)

38199 (UCRL-18140, pp 217-33) ABSORPTION OF ^{212}Pb FROM THE GASTROINTESTINAL TRACT OF MAN. Hursh, John B.; Suomela, Jorma (Univ. of Rochester, N. Y.).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

When ^{212}Pb was administered by mouth to three human subjects, gastrointestinal absorptions of 1.3, 8.1, and 16.0% were found. The method used was to compare 24-hour urinary excretion of these subjects with the average excretion in the same period by two subjects who received ^{212}Pb intravenously. The only obvious factor related to the wide range in absorption was age, increasing age being associated with decreased absorption. The average value of 8% is the same as that used for lead by ICRP-NCRP. It is pointed out that this choice may not be conservative for an appreciable fraction of the population. The ^{212}Pb concentration in the blood cells as function of time suggested that loss may occur only after red cell death. The implications of this to chemical toxicity of lead are considered. (auth)

38200 (UCSF-10-P-2-41) MECHANISMS OF DNA REPAIR IN MAMMALIAN CELLS. Painter, Robert B. (California Univ., San Francisco. Lab. of Radiobiology). Feb. 1968. Contract AT(11-1)-Gen-10. 13p. (CONF-680413-2). Dep. CFSTI.

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco.

Synthesis of DNA in HeLa cells previously grown in BUdR was studied following high doses of uv and x radiation. After irradiation, the cells were incubated with $^{3}HBUdR$ of $^{14}CBUdR$. Density gradients of the cultures are graphed. The findings show that BUdR was incorporated into molecules of normal density at such low frequency that it did not measurably increase their density. This incorporation represents insertion of new bases into preexisting strands, i.e., repair replication. Studies with WI-38 cells demonstrated repair replication after low doses of uv. Chinese hamster cells showed neither unscheduled DNA synthesis nor replication after uv radiation, but showed both after incorporation of BUdR into the DNA. HeLa cell cultures were incubated with $^{14}CBUdR$ for 24 hrs, then with $^{3}HTdR$, and x irradiated. The tritium content of the various fractions of the irradiated cells was not significantly greater than that of controls. The ^{14}C data indicated that a dose-dependent release of BUdR occurred during the irradiation. In general, mammalian cells repair radioinduced damage to DNA by means of a process that involves the removal of damaged bases and insertion of undamaged ones in their place. This DNA is then capable of normal replication and the cell maintains its reproductive integrity. The repair of mammalian DNA differs from that occurring in bacteria in at least one important way: extensive degradation of the DNA does not accompany the process in mammalian cells. Two possible explanations for this difference were proposed and discussed. (H.L.W.)

38201 ADAPTIVE IMMUNITY OF IRRADIATED ANIMALS ASSOCIATED WITH TRANSPLANTATION OF SPLENIC CELLS. Kaulen, D. R. (Inst. of Epidemiology and Microbiology, Moscow). Med. Radiol., 11: No. 11, 76-78(Nov. 1966). (In Russian).

The immune reactions of irradiated mice and guinea pigs to transplanted spleen cells from normal donors and from donors previously immunized against bacteria were analyzed. The mice were exposed to 850 R and the guinea pigs to 500 R of γ radiation. Spleen cell transplants from an immunized donor induced stronger immune reactions in recipients than those induced by cells from normal donors. (R.V.J.)

38202 INVESTIGATIONS WITH ^{47}Ca AND ^{45}Ca ON THE QUESTION OF THE AGE DEPENDENCE OF CALCIUM METABOLISM IN RATS. Glaubitt, D. (Univ., Hamburg-Eppendorf, Ger.). Biophysik, 4: 168-74(1967). (In German).

The kinetics of the metabolism of radioactive calcium is age dependent in rats. In seven to 12 week-old animals, the biological half-life of the whole-body radioactivity and of organ radioactivity was found to be shorter within a given time after intraperitoneal injection of ^{47}Ca than in rats aged at least 8 months. The use of ^{45}Ca gave the same results for organ radioactivity. (tr-auth)

38203 KINETICS OF DISTRIBUTION AND EXCRETION OF LEAD-(^{210}Pb) IN RATS. II. EXCRETION OF A SINGLE INTRAVENOUS LEAD DOSIS. Bolanowska, Wanda; Piotrowski, Jerzy (Instytutu Medycyny Pracy, Lodz, Poland). Med. Pracy, 19: 133-42 (1968). (In Polish).

An investigation was performed in adult albino male rats weighing 200 to 250 g following injection into the tail vein of lead nitrate solution labeled with ^{210}Pb in a single dose of 1.0 and 0.1 mg/kg. The lead excretion in urine and feces was observed during 98 days. The course of excretion is presented. The excretion of lead in feces is a factor that especially decides the amount of total excretion. In the three months period $^{2}/_{3}$ of the lead dose was totally excreted. No essential differences in lead excretion were seen after administration of two different doses of 1.0 and 0.1 mg/kg, nevertheless the excretion of lead in urine was somewhat higher for the lower dose. For the kinetic description of lead excretion, the power and exponential models were used. The extrapolation of excretion equations to infinity seems to confirm the hypothesis of the existence of an unexchangeable deposit, the size of which is evaluated as being about 20% of lead dose. (auth)

38204 STATE OF THE MOTOR FUNCTION IN CHRONIC RADIATION EFFECT. Barabanova, A. V. (Inst. of Industrial Hygiene and Occupational Disease, Moscow). Med. Radiol., 12: No. 8, 42-7(Apr. 1967). (In Russian).

Changes in motor function of radiation personnel were investigated by means of electromyography. The changes were mainly functional; however, mild organic lesions of the nervous system were apparent in some cases. Analysis of the electromyograms revealed different degrees of functional abnormality according to the total radiation dose. Earlier changes were characterized by increased amplitudes of bioelectric activity at rest and in synergy, while later alterations were manifested by decreased amplitudes of bioelectric activity in spontaneous contractions. (H.L.W.)

38205 INFLUENCE OF SUBLETHAL X-IRRADIATION ON IMMUNITY OF GUINEA PIGS ADMINISTERED LIVE TULAREMIA VACCINE. Nutter, John E.; Guss, Maurice L. (Biological Sciences Lab., Frederick, Md.). Proc. Soc. Exp. Biol. Med., 126: 450-2(Nov. 1967).

Sublethal x irradiation of guinea pigs 12 days before to 3 days after subcutaneous vaccination with viable P. tularensis LVS resulted in a maximum mortality of 7.5% at two intervals. Surviving animals, however, displayed an agglutinin response and resistance to respiratory challenge similar to that of nonirradiated vaccinated animals. (auth)

38206 STUDY OF CERTAIN METABOLITES IN THE COURSE OF THE SECONDARY SYNDROME COMPLICATING THE GRAFTING OF ALLOGENIC HEMATOPOIETIC CELLS. Nordmann, R.; Arnaud, M.; Lapeyraque, F. (Clinique Chirurgicale de la Salpetriere, Paris). pp 353-63 of Colloq. Intern. Centre Nat. Rech. Sci., Paris, Sept. 7 to 9, 1964. Paris, Editions du Centre National de la Recherche Scientifique, 1965. (In French).

Metabolic changes were studied in lethally irradiated mice

subjected to bone marrow transplantation using isologous or homologous donors. Mice of the F_1(DBA2 X C57Bl/6) strain, 3 months of age, received a 950 rad dose. Homologous bone marrow cells originated from the F_1(CBA X C57Br) strain, and were infused 20 hr after irradiation. The blood and hepatic levels of some metabolites playing a fundamental role in energy metabolism were determined by specific enzymatic methods. In mice receiving isologous as well as homologous bone marrow transplants, a significant decrease of blood α-ketoglutarate occurred which was thus not related to the secondary disease that developed. Blood pyruvate and lactate levels did not differ from those found in normal animals. The levels of L-malate and nicotinamide adenine dinucleotide (NAD), on the contrary, were significantly and specifically lower in the blood of mice given homologous bone marrow. The hepatic level of NAD showed a decrease in the same mice starved for 24 hr. The concentration of L-malate and L-aspartate was elevated in the liver of fed mice given isologous bone marrow transplantation. Interpretation of these findings is discussed in terms of abnormalities in the biosynthesis of NAD as well as in the metabolism of L-aspartic and L-malic acids. Changes in these metabolites in blood and urine were also studied for several months in a patient after whole-body irradiation and transplantation of allogenic bone marrow. The results are compared with those found in the experiments on mice. (BBB)

38207 EFFECT OF X-IRRADIATION ON HOST RESISTANCE TO THE DWARF TAPEWORM. **Coleman, Robert M.; Carty, Janice M.; Fimian, Walter J. Jr. (Boston Coll., Chestnut Hill, Mass.). Proc. Soc. Exp. Biol. Med., 126: 371-4(Nov. 1967).**

The superimposition of infection by the dwarf tapeworm, Hymenolepis nana, on mice exposed to either 450 or 650 R of whole-body x irradiation considerably lowered host survival. Larger worm loads were observed in mice surviving radiation exposure and infection. Infections persisted for longer periods of time and at higher levels (in terms of worm number) in irradiated hosts as compared to those not irradiated. However, increased susceptibility and lowered immunity, as exhibited by irradiated (450 R) hosts, did not appear to permit autoinfection to take place. Streptomycin therapy produced a striking increase in the survival of irradiated, infected mice. (auth)

38208 SKELETAL CELL PROLIFERATIVE RATES: STUDIED AUTORADIOGRAPHICALLY IN MICE WITH INCREASING DOSES OF TRITIATED THYMIDINE (H^3TDR). **Manspeizer, S.; Tonna, E. A. (Albert Einstein Coll. of Medicine, N. Y. Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med., 126: 331-5(Nov. 1967).**

An autoradiographic study of mouse skeletal cell proliferation rates using increasing doses of tritium-labeled thymidine (^{3}HTDR) were reported. The data showed that in both the osteogenic cells of the femoral periosteum and epiphyseal plate the labeling indices increased rapidly with increasing doses of ^{3}HTDR to 1.0 μCi/g body weight and less rapidly with larger doses. It was concluded from this study that previously reported estimates of labeling indices based on lower doses of administered ^{3}HTDR are lower than the actual values. A dose of 1.0 μCi ^{3}HTDR/g body weight is recommended for the estimates of labeling indices using the flash labeling technique. However, doses of 1.0 μCi and above are not to be used for cell migration or cell kinetic studies. (auth)

38209 RATE OF INITIAL ENTRY OF ^{47}Ca AND ^{85}Sr FROM THE INTESTINE INTO THE VASCULAR SPACE. **Hart, Hiram; Spencer, Herta (City Coll., New York). Proc. Soc. Exp. Biol. Med., 126: 365-71(Nov. 1967).**

The rate of initial entry of both radioactive calcium and strontium from the gastrointestinal tract into the vascular system was determined in man by adapting an integral equation approach for use with a digital computer. A single tracer dose of ^{47}Ca and of ^{85}Sr was given both by the oral and intravenous route in separate studies and serial samples of plasma were obtained for radioassay. The maximal rate of initial entry of ^{47}Ca per 15-minute interval ranged from 2.2% to 3.8% of the dose and was reached within 1½ hours. This rate was sustained for about one hour and decreased thereafter with time. The rate of initial entry for ^{85}Sr was less than that for ^{47}Ca, not exceeding 1.5% of the dose in any 15-minute interval, but was relatively more sustained from the first to the fourth hour. After the fourth hour, the rates of initial entry of ^{85}Sr and ^{47}Ca were almost proportional. (auth)

38210 γ-IRRADIATION OF MYOGLOBINS. Ho, Lydia Suyong. Berkeley, Calif., Univ. of California, 1967. 83p.

Thesis

Three components were resolved from crystalline sperm whale myoglobin by DEAE-cellulose columns, and the main fraction was further fractionated into three components by CM-cellulose columns. All these multiple forms had comparable molecular weights but different charges. Similar results were obtained for yellowfin tuna myoglobin. Gamma irradiation of metmyoglobin solutions at 500 Krads at ambient temperatures caused changes in visible and ultraviolet spectra; no appreciable change in amino acid composition; no significant change in binding of myoglobin with malonaldehyde; and a faster autoxidation rate of oxymyoglobin. (Diss. Abstr.) (TSS)

38211 THE NATURE AND MECHANISM OF THE EFFECTS OF RADIATION AND A THIOL REAGENT ON THE HUMAN ERYTHROCYTE MEMBRANE. Sutherland, Robert Melvin. Rochester, N. Y., Univ. of Rochester, 1966. 214p.

Thesis.

The characteristics of the damage to various permeability parameters of the human erythrocyte membrane resulting from x irradiation and treatment with the thiol binding agent p-chloromercuribenzenesulfonic acid (PCMBS) were compared. Treatment of the cells with either agent resulted in similar responses in terms of K and Na permeabilities and hemolysis. The kinetics of K leakage produced by PCMBS is discussed; the effects of the incubation temperature is also included. (Disser. Abstr.) (TSS)

38212 DISTRIBUTION AND RETENTION OF ORALLY ADMINISTERED RADIOTUNGSTEN IN THE RAT. Kaye, Stephen Vincent. Rochester, N. Y., Univ. of Rochester, 1966. 87p.

Thesis.

Two complementary experiments were carried out to collect data on the distribution of tungsten in rat tissues. The first experiment involved the measurement of ^{187}W in urine, feces, blood, plasma, GI tract, and residual carcass of 24 rats over a 72-hr period. The second experiment involved the distribution and retention of ^{185}W in major organs of 70 rats over periods of up to 254 days. The radiotungsten was administered by gavage in one ml of tungstate solution at pH 8 to adult Wistar rats. Samples containing ^{187}W were analyzed by gamma spectrometry, whereas samples containing ^{185}W were counted with a liquid scintillation counter after special preparation of the samples. Measurement of ^{187}W in carcass, GI tract, blood, plasma, urine, and feces over a 72-hour period disclosed that tungsten was rapidly absorbed from the GI tract; but that a major fraction was promptly removed via urine. This route accounted for elimination of more than 40% of the administered dose by 12 hours post administration, but after 72 hours the amount in urine had increased by only a couple of per cent. About 50% of the administered dose was found in the feces after 72 hours, at which time only 0.08% was still in the GI tract and 0.7% was in the residual carcass. During the first hour all activity in the blood was in plasma, none being associated with the cellular portion; after three days, there were nine times more activity per ml of red cells than per ml of plasma. Long-term studies of ^{185}W disclosed that after 100 days, greater than 99% of the total-body burden was retained in bone with a biological half-life of 1100 days for the slowest component of a three-component elimination curve. The rate of elimination of ^{185}W in urine after 100 days correlated well with the retention parameters for bone. Tungsten could not be detected in feces after 33 days at which time the urine to feces ratio was still decreasing. Incisor teeth reached a peak after 14 days, then decreased in activity until all detectable tungsten was lost after 61 days when the incorporated tungsten wore off at the grinding surfaces. Extensive data were accumulated which indicate that tungsten is non-specific for soft tissues except for spleen and hair. The combined data from the two experiments were used to calculate biological internal dosimetry parameters. (Diss. Abstr.) (TSS)

38213 PHOTOALLERGY TO SANDALWOOD OIL. Starke, James C. (St. Joseph's Hospital, Nashua, N. H.). Arch. Dermatol., 96: 62-3(July 1967).

Allergic reactions to uv light in skin treated with sandalwood oil were demonstrated. Triplicate patches were applied using the patient's cosmetics, bithionol, tetrachlorosalicylanilide, and tribromosalicylanilide. A sunshine fluorescent bulb having a peak emission of 2800 to 3600 Å was used for initial skin testing. When placed two in. from the skin, the minimal erythemal dose (MED) was one min in the normal individual. The patient was then irradiated to determine his MED (30 sec). One set of patches was removed and irradiated for 10 sec (suberythemal dose). The second set was irradiated for six min (12 times the MED). Twenty-four hr later the third set of patches was removed. Irradiated patch tests to sandalwood oil were positive. Tests were also conducted on some of the ingredients of commercial sandalwood oil: synthetic geranium, geranium bourbon (natural distillate), synthetic and natural sandalwood oil, cedar wood oil, and patchouly oil. The patient had a positive closed patch test to commercial sandalwood oil, geranium bourbon, and synthetic geranium oil. (BBB)

38214 INHIBITION OF tRNA METHYLASES IN LYSOGENIC ORGANISMS AFTER INDUCTION BY ULTRAVIOLET IRRADIA-

TION OR BY HEAT. Wainfan, Elsie; Srinivasan, P. R.; Borek, Ernest (Columbia Univ., New York). J. Mol. Biol., 22: 349-53 (1966).

The tRNA methylase (RNA methyltransferase) activities decreased in extracts from Escherichia coli K12 (λ^+) after exposure of the cells to inducing doses of uv radiation. This reduction after uv induction was traced to the appearance of a stable, dialyzable inhibitor of the methylases. Moreover, a parallel phenomenon resulting in depressed tRNA methylase activity was also established after induction by heat in lysogenic organisms prone to such induction. E. coli K12W 6(λ^+) were induced by uv irradiation of logarithmic phase cells in a mineral-glucose medium at 37°C. The uv doses used resulted in the induction of 90% or more of the population. Irradiated cells were incubated in the dark at 37°C and then chilled and harvested. Two nonlysogenic strains of E. coli were irradiated and incubated in the same way. The tRNA methylase capacities of enzyme extracts derived from different organisms after various treatments are given. It was evident that the reduction in methylase capacities only followed induction of lysogenic organisms. Neither E. coli B nor a nonlysogenic variant of E. coli K12 had altered methylase activities after uv irradiation. On the other hand, induction either by uv irradiation or by heat in the organisms that responded to such a stress was followed, after an interval, by a reduction in the tRNA methylase activity. (BBB)

38215 EXAMINATION ON PEROXIDASE REACTION IN BONE-MARROW AND PERIPHERAL BLOOD OF GUINEA-PIGS FOLLOWING A WHOLE-BODY IRRADIATION OF 600R. zur Horst-Meyer, H.; Mangakis, N. (Univ., Berlin). Radiobiol.-Radiother., 8: 767-71(1967). (In German).

Following 600 R whole-body x-irradiation, peroxidase reaction of granulocytes of guinea-pigs will not be changed despite a very large decrease in granulocyte and lymphocyte count in the peripheral blood with a shift of nuclear fragment index of granulocytes and structural change of bone-marrow. (auth)

38216 TRANSPLANTATION TOLERANCE INDUCTION IN ADULT MICE DIFFERING AT THE H_2 LOCUS. Liacopoulos, P.; Herlem, G.; Perramant, M. F. (Hopital Broussais, Paris). Ann. Inst. Pasteur, 113: 475-82(Oct. 1967). (In French).

The principle of functional inhibition of immunologically competent cells by treating animal donors with an antigen unrelated to the transplantation antigens was applied to mouse strains with very strong histoincompatibility in which death of the host frequently resulted. Male host mice (A/J strain) were x irradiated with 700 R from a 225-KV source which resulted in 70 to 80% mortality. The donors (CBA strain) were treated with rabbit γ-globulin in doses of 100 mg/day for 10 days. Spleen cells (80 to 90% viable) of the donor were injected intravenously in the host 25 hr after irradiation. The strain of mice used differed in the H_2 locus. Consequently, the reaction of spleen cells of the donors in the irradiated hosts resulted in a high mortality (80%). Donor treatment with large doses of rabbit γ-globulin produced inhibition of the graft-vs-host reaction, resulting in a decrease of mortality of only 20%. Nearly all A/J survivors of irradiation which received 25×10^6 or more donor spleen cells became tolerant of CBA tissues and permanently (more than 1 yr) accepted donor skin grafts. This tolerance was due to the establishment of a chimeric state; cytologic studies showed that in mice tolerant since more than 6 months, about 50 to 90% of their lymph node cells as well as their red blood cells were of donor origin. (BBB)

38217 INVESTIGATIONS ON THE METABOLISM OF ^{224}Ra (ThX) AND ESTIMATION OF THE RADIATION DOSES IN THERAPEUTIC USES. Grillmaier, R.; Muth, H.; Oberhause, E. (Univ., Saarlandes/Homburg, Ger.). Biophysik, 4: 266-82(1968). (In German).

The time pattern of radium concentration in the serum in two patients after a single injection of ^{224}Ra can be described, for the observation time of 7 days, by a linear combination of three ϵ functions. Two of the compartments assumed in the model can be identified with the extracellular space and the intercellular space. The deposition of the Ra of the extracellular space in the non-exchangeable part of the skeleton amounts to 10% per hour. The Ra was eliminated from the extracellular space over the gastrointestinal track and the kidneys by 16% and 9%, respectively. The renal clearance is 1.2 l in 24 hrs. The retention of the Ra in the total organism was determined as 73% after one day in one patient and 71% in the other patient. The radiation doses were estimated and the results were tabulated. (tr-auth)

38218 BALANCE OF ^{137}Cs AND POTASSIUM, AND WHOLE-BODY LEVELS IN YOUNG MALE SUBJECTS. Ward, Gerald M.; Johnson, James E. (Colorado State Univ., Fort Collins). Amer. J. Clin. Nutr., 21: 149-53(Feb. 1968).

Balances of ^{137}Cs and K in normal subjects and the relation between ^{137}Cs intake and body burdens of the burdens of the fission product were investigated. The study included two levels of ^{137}Cs and K intake, and resulting balances for each element and whole-body levels were estimated by whole-body counting. Normal young male subjects 18 to 21 yr of age were divided into two groups, one consisting of eight men receiving a ration which averaged 123 pCi of ^{137}Cs and 2.7 g of K per day during a 34-day experimental period. The second group consisting of four men received a ration which averaged 279 pCi of ^{137}Cs and 5.9 g of K per day. The higher intake resulted in significant positive balances for both elements. The lower levels produced essentially zero balances. The higher ^{137}Cs intake resulted in significant increase in the whole-body level of ^{137}Cs (17.8 to 29.3), but the increase was not entirely proportional to differences in dietary intake. The Cs-to-K ratio was similar to the two diets and also for both urine and feces, ranging from 30 to 50 pCi ^{137}Cs/g K. (BBB)

38219 L-GLUTAMINASE ACTIVITY IN MOUSE AND RAT KIDNEY IN THE COURSE OF POISONING WITH URANYL NITRATE. Bastide, Janine; Bastide, P.; Dastugue, G. (Faculte Mixte de of Medecine et Pharmacie, Clermont-Ferrand, France). Pathol. Biol., Sem. Hop., 14: 833-7(Aug.-Sept. 1966). (In French).

Observations were made on the variations of L-glutaminase in studies on renal enzyme activity during experimental poisoning with uranyl nitrate. A single intraperitoneal injection of an aqueous solution of uranyl nitrate was given, for mice, 1 ml of a solution of 400 mg/l per 20 g body weight and for rats, 1 ml of a solution of 2 g/l per 100 g of body weight. The animals were killed at 24, 48, 72, and 96 hr after injection. The enzymic effects of the nephritis caused by uranyl nitrate were as follows: in experiments on 132 mouse kidneys and 88 rat kidneys, a marked increase in L-glutaminase activity was observed, in 100% of the rats and 70% of the mice. However, biuret-reacting proteins were noticeably decreased. In the rat, erythrocyte enzyme activity appeared very weak and plasma activity appeared only in traces (2 to 5% even after 24-hr incubation). The results were discussed with reference to those found in the literature. (74 references). (BBB)

38220 EFFECT OF ADMINISTRATION ROUTE UPON ^{59}Fe RETENTION IN MINIATURE SWINE AS MEASURED IN A 2-pi LIQUID SCINTILLATION WHOLE-BODY COUNTER. Tumbleson, M. E.; Dommert, A. R.; Wescott, R. B.; Coffman, W. J. (Univ. of Missouri, Columbia). J. Anim. Sci., 27: 83-7(Jan. 1968).

A custom-built whole-body counter which has a 2-pi liquid scintillation six-module detector and a two-channel spectrometer is described and was used to study ^{59}Fe retention, as affected by route of administration, in three-week-old Hormel strain miniature swine. Approximately 75% of the injected ^{59}Fe was retained during the 28-day experimental period. Iron retention in individual pigs ranged from 62.5 to 84.9%; however, no significant difference due to route of injection was detected. Males retained 77.5% of the injected ^{59}Fe, whereas females retained only 72.6%. Percent retention 24 hr postinjection varied considerably with route of injection. The mean percent retention was 89.4. There was a significant linear correlation between body weight and percent retention 28 days postinjection. Retention after 24 hr was not affected by body weight, but at 28 days postinjection appreciably less radioactivity was detectable in the larger animals. The pigs weighed an average of 3.28 Kg at the initiation and 5.37 Kg at the termination of the trial. (BBB)

38221 CELLULAR KINETICS OF PERIPHERAL NERVE AND STRIATED MUSCLE AFTER A SINGLE DOSE OF X RAYS: A HISTOLOGICAL AND AUTORADIOGRAPHIC STUDY, USING ^{3}H-THYMIDINE. Hassler, O. (Univ. of Umea, Sweden). Z. Zellforsch. Mikroskop. Anat., 85: 62-6(1968).

Incorporation of ^{3}H-thymidine in the irradiated mouse brain underwent a marked increase in neuroglia cells four to 30 days after irradiation. Whether a similar increase of ^{3}H-incorporating cells after irradiation could be obtained in a peripheral nerve (sciatic nerve) was studied. The striated muscle innervated by the irradiated nerve was also studied, because changes secondary to the nerve injury could occur, as well as direct, primary, radiation effects. Furthermore, the mast-cell component of the peripheral nerve was especially examined because no information concerning its behavior in radiation injuries was found in a review of the literature. Mice were x irradiated with a single dose (2760 rad) over one leg while the rest of the body was shielded by lead. The animals were killed one to 270 days after irradiation and ^{3}H-thymidine was injected two hr before death. Sections from the sciatic nerve and its innervated muscles were examined by autoradiography and by special methods for mast cells. No changes in the endoneural mast-cell component could be seen after irradiation. At all times after irradiation, the numbers of labeled Schwann-cell nuclei and the sarcolemma-cell

nuclei were moderately decreased on the irradiated side, when compared with the control side. (BBB)

38222 CYTOLOGICAL SHIFTS IN THE SPLEEN AND THE TYPES OF ANTIBODIES OBSERVED AT THE PRIMARY IMMUNOLOGICAL RESPONSE IN INTACT AND IRRADIATED RATS. Kartasheva, A. L.; Kashkin, K. P.; Rudakov, I. A. (Inst. of Medical Radiology, Obninsk, USSR). Tsitologiya, 9: 1427-31 (Nov. 1967). (In Russian).

Wistar rats were immunized with a once-repeated intraperitoneal injection of sheep erythrocytes (1 ml, 220×10^6 cells). One portion of rats was then irradiated with ^{60}Co γ-rays at a dose of 600 R on days 1, 2, 3, and 4 after immunization. Cellular reactions and dynamics of accumulation of antibody-synthesizing cells in the spleen as well as the level of circulating 7 S and 19 S antibodies at primary immunization of the animals were investigated. By the fifth day after immunization a threefold increase of cellular mass of the spleen due to increase of lymphoid elements in this organ was observed. Plasma cells at the period of their greatest accumulation comprised 2.8% of the total cell population of the spleen, of which 0.6% took part in antibody synthesis. Irradiation on the 1st or 2nd day after antigen injection equally inhibited biosynthesis of 7 S as well as 19 S antibodies, while irradiation on the 3rd day after immunization had a selective effect on biosynthesis of the 7 S antibodies resistant to 2-mercaptoethanol. The results confirmed that the same cellular elements take part in biosynthesis of heavy and light antibodies. (auth)

38223 ANTIBODY PLAQUE-FORMING CELLS IN UNSENSITIZED MICE: SPECIFICITY AND RESPONSE TO NEONATAL THYMECTOMY, X IRRADIATION, AND PHA. Hege, John S.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). J. Immunol., 99: 61-70(July 1967).

By the standard antibody plaque technique, numbers of background anti-sheep erythrocyte plaque-forming cells (PFC's) in spleens of unsensitized mice were determined after neonatal thymectomy, whole-body x irradiation, and injection of phytohemagglutinin M or typhoid-paratyphoid vaccine. The results showed that numbers of background PFC's were not affected by neonatal thymectomy or by whole-body x irradiation at dose levels known to inhibit cellular proliferation but that they were significantly increased (10 to 20 fold) by phytohemagglutinin, typhoid vaccine, and other unrelated antigens. Whole-body irradiation produced a decrease in background PFC's determined at two or seven days after irradiation, but only at doses greater than 200 RAD. Simultaneous determinations of background anti-sheep erythrocyte and anti-horse erythrocyte PFC's indicated that these two populations were independent of one another. It was concluded that background PFC's produced specific hemolysin, were thymus independent, relatively long lived (average life about 7 days), and not related to the antigen-sensitive precursor cells of the primary response PFC's. (BBB)

38224 FURTHER OBSERVATIONS CONCERNING THE EFFECT OF ACTINOMYCIN D ON THYROIDAL IODIDE TRANSPORT IN RATS. Halmi, N. S.; Gifford, T. H.; Giesne, R. E. (Univ. of Iowa, Iowa City). Endocrinology, 81: 893-8(Oct. 1967).

Previous findings from this laboratory concerning the ability of actinomycin D (act D) to enhance the thyroid/serum radioiodide concentration ratio (T/S) (3) were confirmed. This effect was not because of altered food intake, since it could be elicited in fasted animals. Actinomycin D did not interfere with the blocking influence of propylthiouracil on organic binding of ^{131}I in the thyroid. A raised thyroid/medium radioiodide concentration ratio (T/M) could be observed when glands from intact rats injected with act D were incubated in a medium containing methimazole and ^{131}I. The elevating influence of TSH injected into hypophysectomized rats on the T/M established by their thyroids was not affected by act D given concurrently with the TSH. In contrast to the previous study (3), we found that act D consistently raised the T/S of untreated hypophysectomized rats. When it was given before the injection of a single dose of TSH into such animals, it did not prevent the initial drop in T/S. At or near the height of the T/S-raising effect of TSH, further elevation of the T/S by act D was erratic, but it became clear-cut again by the time the influence of TSH had waned. 5-Fluorouracil injected into intact rats in doses from 40 to 300 mg did not elevate the T/S. (TSS)

38225 STRONTIUM AND CALCIUM DISTRIBUTION IN MAJOR VEGETABLE AND FRUIT CROPS AND CRITERIA FOR USE OF FALLOUT-CONTAMINATED FOODS. Ralls, J. W.; Primbsch, S.; Guckeen, T. R.; Maagdenberg, H. J.; Rinehart, J.; Lamb, F. C.; Mercer, W. A. (National Canners Association, Berkeley, Calif.). Radiol. Health Data Rep., 8: 355-8(July 1967).

Vegetable and fruit crops were grown in soil enriched with high levels of strontium nitrate. The normally edible portions of the crops were harvested and sectioned into anatomically distinct portions. The strontium and calcium content was measured by flame spectrophotometry or by photon activation analysis. The results are tabulated to provide an upper limit for radiostrontium content of crops grown in soil heavily contaminated with debris from nuclear fission on a massive scale. (auth)

38226 RADIATION SENSITIVITY OF SPLEEN CELLS IRRADIATED IN VITRO AND IN VIVO. Maruyama, Yosh; Eichten, John G. (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 46-52(Jan. 1968).

X irradiation survival response by colony-forming ability was determined for mouse spleen cells. Cells irradiated in vitro or in vivo differed in their radiosensitivity, and cells irradiated in vivo were less sensitive than cells irradiated in vitro. The differences appeared to be due to a difference in the slope or D_0 of the survival curve. D_0 in vivo was 109 RAD, and in vitro was 91 RAD. Oxygen breathing did not alter radioresponse. The extrapolation of cell radioresponse observed in vitro to the in vivo situation may be limited under certain circumstances. (auth)

38227 STUDIES ON RADIATION RENAL DAMAGES. III. CHANGES OF BLOOD PRESSURE AND SERUM BIOCHEMICAL AND HISTOLOGICAL PICTURES FOLLOWING X RAY IRRADIATION TO THE KIDNEY OF ADULT DOG. Miroguchi, Masaru (Hiroshima Univ.). Hinyokika Kiyo, 12: 1078-94(Oct. 1966). (In Japanese).

X-ray irradiation was administered to the left kidney of Mongolian dogs with the doses of 1,000, 1,500, 2,000 and 3,000 R, respectively. Blood pressure, alteration of serum biochemical findings, and histological pictures were determined after irradiation. Half the dogs of each group were nephrectomized on the right side, and one group without irradiation was reserved as the control. In the unilateral kidney groups, blood pressure increased after irradiation with no difference in the doses given. In the bilateral kidney groups, the increase in blood pressure was not consistent. After irradiation, the serum Na, Cl, and Ca showed no change, whereas K showed a marked and immediate increase, followed by a temporal decrease and further increase in the terminal stage. BUN showed a gradual increase, followed by a temporal decrease and rapid increase in the terminal stage. Macroscopically the irradiated kidney showed deformity, adhesion to the surrounding tissue, and atrophy of the cortex. In the bilateral kidney groups, the irradiated kidney weighed less than the other; however, in the unilateral kidney groups it gained weight in the 1,000 and 1,500 R irradiations. Histologically the irradiated kidney showed a destruction of renal tubuli with fibrous replacement, atrophy with hyaline degeneration of glomeruli, and so on, with some degeneration also in the non-irradiated kidney. (NSA of Japan)

38228 DEUTERIUM ISOTOPE EFFECTS IN CLAVICEPS PURPUREA. Mrtek, Robert George. Urbana, Ill., Univ. of Illinois at the Medical Center, 1967. 183p.

Thesis.

Deuterium isotope effects in Claviceps purpurea were investigated. The effects of deuteriation on the saprophytic culture of the fungus, and the isotopic incorporation at each molecular site in elymoclavine obtained from deuteriated cultures were studied. Claviceps purpurea, strain 47A, did not require a carbohydrate source in order to metabolize and produce alkaloids in H_2O or 50% D_2O in the presence of succinic acid. The total amount of alkaloid produced increased with increasing succinic acid concentration. Low concentrations of deuterium oxide (50% D_2O) stimulated alkaloid production. Higher levels of deuteriation inhibited alkaloid production to the extreme (above 90% D_2O) when no alkaloids were produced at all. The growth of the fungus became progressively inhibited when succinate was supplied as the only C–H substrate. Above 75% D_2O, a carbohydrate carbon source became indispensable, and fully deuteriated Claviceps could be cultured. The primary deuterium isotope effect in the ergot biosystem appeared to result from the presence of D_2O in the medium solution rather than in the carbon-hydrogen substrates. The organism appeared to have little difficulty in utilizing either protio- or deuteriosubstrates, but the incorporation of either of these into a medium of greater than 90% D_2O failed to elicit alkaloid production. Replacement culture techniques were used to obtain deuteriated alkaloids from a 98% D_2O medium which contained fungal tissue originally grown in H_2O. Mycelia obtained from fully or partially deuteriated growth cultures did not produce alkaloids when replaced in fluid cultures which contained either H_2O or D_2O plus precursors. Alkaloids obtained from D_2O replacement cultures with specific deuteriated precursors were subjected to NMR analysis for isotope incorporation at each molecular position. Complete NMR analysis was performed for the clavine alkaloids: setoclavine, penniclavine, agroclavine, and elymoclavine. The infor-

mation obtained from NMR studies with authentic samples of these alkaloids was extended to the analysis of samples of deuteriated elymoclavine from four different culture conditions. Positional isotope analysis indicates that the biosynthesis of elymoclavine from phenylalanine and succinic acid did not follow from a simple utilization of precursors. The substrates were apparently degraded extensively, C–H positions were exchanged with the hydrogen of water, and the clavine alkaloids were assembled from relatively small carbon-containing fragments. The data indicate that the role of water in the biosynthesis of the clavine alkaloids is extensive. The combined techniques of deuterium substitution and nuclear magnetic resonance analysis can be extremely valuable in elucidating the biologic mechanisms involved in the synthesis of compounds which are as complex as the alkaloids of ergot. The value of this method is best realized when one considers that, unlike the analysis of radioactively labeled compounds, deuteriated alkaloids may be accurately analyzed one molecular position at a time for both the qualitative and quantitative incorporation of the heavy isotope, without any destruction to the sample. Furthermore, chemical modification of the alkaloids was unnecessary, resulting in total recovery of the analyzed compounds. With the ergot alkaloids, recovery of the intact compound is especially important, since the pharmacology of this active group of drugs may be highly dependent upon the extent of deuteriation. It appears possible to obtain a completely deuteriated ergot alkaloid from replacement cultures utilizing normal hydrogen tissue. The organism metabolizing in a milieu of completely deuteriated substrates, joins the appropriate fragments together, drawing hydrogen from a pool of the medium, and thereby synthesizing alkaloids of a preselected isotopic concentration. (Disser. Abstr.)

38229 EARLY AND LONG-TERM EFFECTS OF DEUTERON IRRADIATION ON CELLS IN THE CEREBELLUM OF ADULT MICE. Samorajski, T.; Ordy, J. M.; Zeman, W.; Curtis, H. J. (Cleveland Psychiatric Inst. Indiana Univ. Medical Center, Indianapolis. Brookhaven National Lab., Upton, N. Y.). J. Cell Biol., 38: 213-20(May 1968).

Morphologic studies on cerebellar neurons of adult C57BL/10 female mice that were exposed to deuteron beams delivered by by the 60 inch Brookhaven cyclotron at a dose of 10,000 RADs over the parietal, visual, and cerebellar cortex and extending to a depth of 2.0 mm from the skull are described. Observations with the light microscope indicated an accumulation of phagocytes containing cellular debris adjacent to blood vessels at 40 and 480 days after irradiation. Comparisons in the electron microscope of early and long-term ultrastructural changes revealed an accumulation of cytoplasmic fibrils and glycogen granules in reactive astrocytes and the formation of multilamellar membranes surrounding the perikarya of granule cells at 40 and 480 days after irradiation. Multilamellar intracytoplasmic membranes adjacent to the nuclei of some unidentified cells were observed only at the longer post-irradiation interval. (auth)

38230 RADIATION INDUCED THERMOLUMINESCENCE OF TOMATO SEEDS AT LOW TEMPERATURE. Chadwick, K. H.; Oosterheert, W. F. (EURATOM–ITAL, Wageningen, Netherlands). pp 633-41 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The thermoluminescence of tomato seeds irradiated at liquid nitrogen temperature with x rays was found. The complete seed shows a linear dose relationship from 5 to 100 Krad. Both the embryo, which is largely protein, and the seed coat, which is largely carbohydrate, exhibit thermoluminescence. (auth)

38231 CLEARANCE RATES AND INDEX OF CIRCULATORY ACTIVITY OF ^{133}Xe IN CANCEROUS TISSUES. Bru, A.; Combes, P. F.; Vergnes, R.; Regis, H.; Naja, A. (Centre Regional Anticancereux, Toulouse). pp 1260-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907–(Vol.2).

Equations are given for calculating the supply of ^{133}Xe to an organ and for determining the state of equilibrium between the blood and tissue concentrations resulting from diffusion across the cell membrane. Tables are presented to show the rate of clearance of ^{133}Xe in benign and malignant tumors of the breast and thyroid. It was found that the circulatory activity of neoplastic tissue was extremely variable and was not related to the histological structure of the tumor. The effect of radiotherapy was to cause a decrease in the circulatory activity of the neoplastic tissue. Results of ^{133}Xe studies showed a very high rate of circulatory activity in cases of thyroid hyperplasia and a close parallelism between the level of iodine metabolism and circulatory activity. In the case of necrotic nodules suspected of being malignant, the rate of ^{133}Xe clearance could be used to make the determination; a time interval between two and four minutes would indicate malignancy. (H.L.W.)

38232 INVESTIGATIONS OF ^{85}Sr METABOLISM WITH A WHOLE-BODY COUNTER. EVALUATION OF THE METHOD FOR DETERMINATION OF TUMOR EXTRACTS FROM BONES. Schaefer, P.; Koeppe, P. (Freie Univ., Berlin). pp 1302-6 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907–(Vol.2).

By means of the Berlin Whole Body Counter, the retention of ^{85}Sr was studied in 29 patients with various diseases with and without involvement of the skeletal system. The retention of ^{85}Sr was found to be higher in patients with Paget's disease of bone, skeletal metastases and osteoporosis; it was also found to be higher in patients with Hodgkin's disease. Clinically and radiologically the skeletal system of these latter patients did not appear to be involved. This finding is discussed in the light of the known bone-seeking properties of ^{85}Sr under physiological conditions. The question is asked if, under pathological conditions, changes of the soft tissues may show an increased retention of ^{85}Sr as well. (auth)

38233 STUDIES ON THE RETENTION AND REDISTRIBUTION OF ^{85}Sr AND ^{47}Ca IN HUMANS BY WHOLE-BODY COUNTING AND LOCAL MEASUREMENTS. Cederquist, E. (University Hospital, Lund, Sweden). pp 1326-32 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907–(Vol.2).

The whole-body counting technique described can record kinetic aspects of the behavior of gamma-emitting bone-seeking isotopes. It appears to be useful not only in practical diagnostic work but also in investigations of skeletal metabolism. In the measurement of whole-body retention, it can replace the time-consuming technique of excreta assay. The measuring technique can be done as an outpatient procedure. Its high sensitivity makes it possible to carry out long-term studies over months following, for example, a single intravenous injection of less than 1 μCi of ^{85}Sr. With the method measuring the patient prone and supine and the counting rate as a ratio, it seems possible to be able to distinguish between patients with and without widespread skeletal disease often within one hour. (auth)

38234 MOLECULAR NATURE OF RADIATION LESIONS AS DEDUCED FROM EXPERIMENTS WITH ULTRAVIOLET LIGHT. Johns, H. E. (Ontario Cancer Inst., Toronto). pp 1383-90 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907–(Vol.2).

Ultraviolet light is probably of little or no value in treating malignant diseases, however it has an advantage in radiobiology because the energy of one photon of the radiation is absorbed in a particular bond and brings about a very specific type of damage in exposed cells. The amount of damage can be measured by separating out the photoproducts by chromatography. The biological change produced in the DNA and RNA can then be investigated by a number of techniques and the loss in biological activity related to the particular damage produced. Studies of this kind shed light on the more complex problems that occur when ionizing radiations are absorbed by cells. (auth)

38235 FURTHER STUDIES ON DECORPORATION OF RADIOSTRONTIUM: ANIMAL EXPERIMENTS. Setala, Kai (Univ. of Helsinki). pp 1604-8 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907–(Vol.2).

Studies on the metabolism of ^{85}Sr, ^{89}Sr, and ^{90}Sr in mice following intragastric administration demonstrated that quantitative in vivo determination of ingested radiostrontium was possible on a live animal. On the basis of the results of the animal experiments it was concluded that it is not relevant to speak of an irreversible accretion of radiostrontium into the skeleton as this concept is to be understood as a relative one only. For studies of eventual accretion into, and departure from the skeleton of the so-called bone-seeking radionuclides, only quantitative assay techniques that allow continuous follow-up of the kinetics of the active material on a live animal are of value. (auth)

Ecology

Refer also to abstracts 38253 and 38501.

38236 (COO-1281-6) ECOLOGICAL STUDY OF CHAOBORUS. Maluег, Kenneth Wilbur (Wisconsin Univ., Madison). 1966. 255p. Dep. CFSTI.

Thesis.

The following aspects of the ecology of the insect, Chaoborus, in Wisconsin lakes were investigated: collection of limnological data from the lakes; life cycle studies of Chaoborus from Tub Lake; vertical migratory habits of Chaoborus; and determination of the ability of this insect to transport ^{131}I from hypolimnetic waters of a thermally stratified lake. Studies on rate of movement, determined for hourly intervals over a 24 hr period, suggested a positive relationship with both an optimum light intensity and the rate of change in the logarithm of the light intensity. Iodine-131 was released in the hypolimnion of Tub Lake in 1964 and 1965 during a period of thermal stratification. Background radiation was measured in the water and mud of the lake prior to introduction of the isotope. Profiles of background radiation from surface to bottom mud showed high values at the surface, lower but constant values throughout the water column, substantially higher values at the mud-water interface, and lower values deeper in the mud. The radionuclide proved to be a valuable tracer in studying water movement. The maximum rate of horizontal movement at the time of summer stagnation was 29 m in the first 24 hr at the 5 m depth. The thermocline served as a barrier to the physical transport of the isotope from hypolimnion to epilimnion. Radioactivity in zooplankton, fish, and adult dipterans increased after introduction of the isotope. Nighttime zooplankton samples from the epilimnion were substantially higher in radioactivity than daytime samples. It was determined that the increase in radioactivity in the nighttime samples was caused by migrating Chaoborus. Fish did not enter the anoxic hypolimnetic layer during the experiment. However, they became radioactive. An abundance of Chaoborus larvae and pupae found in the stomachs of the collected fish suggested that the fish preyed upon the migrating, radioactive Chaoborus when they entered the waters of the epilimnion. (H.L.W.)

38237 (ORNL-TM-2104) SECONDARY SUCCESSION IN ABANDONED CULTIVATED FIELDS: AN ANNOTATED BIBLIOGRAPHY. Haug, P. T.; Van Dyne, George M. (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 70p. Dep. CFSTI.

The significance of successional studies on old-field systems for events that might follow a thermonuclear attack is discussed. A bibliography of 120 references with abstracts is presented. A computer index of key words is included. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 38193, 38427, and 38492.

38238 (BNL-12190) GENETIC AND CYTOLOGICAL STUDIES OF TRADESCANTIA IRRADIATED DURING ORBITAL FLIGHT. Sparrow, A. H.; Schairer, L. A.; Marimuthu, K. M. (Brookhaven National Lab., Upton, N. Y.). [1967]. (CONF-680205-1). Dep. CFSTI.

From Symposium on the Biosatellite II Experiments, Washington, D. C.

Plants were placed in plastic packages for irradiation during space flight. Controls consisted of similar packages for ground experiments. The plants were a special clone of Tradescantia heterozygous for flower color. Inflorescences were arranged to receive a uniform two-day exposure totaling 220 R from a ^{85}Sr source. Following retrieval, mutations in flower color and size and shape of stamen hairs were noted. Cytological studies were conducted on microspores and root tips. Results are presented in the form of tables and graphs. There was no general effect on mutation rate attributable to space-craft factors. Analyses of frequencies of various chromosome aberrations suggest that significant differences between flight and ground samples will not be found. Irradiated flight samples had higher rates of pollen abortion and stamen hair stunting; this suggests a synergistic interaction between weightlessness and irradiation. Cytological aberrations were observed more frequently in flight samples than in ground samples. (H.L.W.)

38239 CHROMOSOME ABERRATIONS AND THE CELL CYCLE. Wolff, Sheldon (Univ. of California, San Francisco). Radiat. Res., 33: 609-19(1968).

When cells were irradiated with ionizing radiation, one of the readily observed effects was the production of chromosome aberrations. These aberrations of the genetic apparatus led to drastic effects on cell division and cell survival. Different types and amounts of aberrations were induced at different stages of the cell cycle according to the submicroscopic organization of the chromosomes and nuclei within the stages. Thus at prophase each chromatid acted as though double in its response to radiation, whereas later, after the chromatid became a daughter chromosome and entered G_1 of the next cycle, it acted as though single. Such changes had profound implications for our understanding of chromosome structure. Aberrations that led to anaphase bridges prevented cytokinesis. Others that led to genetic imbalance among the daughter cells led to lowered survival. It was not clear, however, how important this imbalance was in studies of cells in tissue culture, for these cells were grown in fairly complete media and could stand a large amount of polyploidy and aneuploidy. (auth)

38240 ISOLATION OF A RADIOSENSITIVE MUTANT OF SACCHAROMYCES: SENSITIVENESS OF COLONY-FORMING CAPACITY, OF RNA- AND PROTEIN SYNTHESES. Laskowski, W.; Lochmann, E.-R.; Jannsen, S.; Fink, E. (Univ., Berlin). Biophysik, 4: 233-42(1968). (In German).

A radiosensitive strain was isolated from a Saccharomyces culture. By tetrad analysis it was shown that the radiosensitivity was due to a gene mutation. The mutated gene, r_1^s, made haploid cells three to six times more sensitive to uv and approximately twice as sensitive to x rays. Homozygous diploid cells ($r_1^s r_1^s$) were approximately 2.5 times more sensitive to uv and x rays than wild-type cells (++). In both haploid and homozygous diploid cells photoreactivation and dark-recovery on agar without nutrients were not blocked by gene r_1^s. In comparison to wild-type strains, the rate of RNA synthesis in the radiation-sensitive strains was reduced after uv and after x irradiation whereas the rate of protein synthesis was reduced only after uv irradiation. (auth)

38241 GENETIC STUDIES IN EUDORINA. Mishra, Nawin C. (Rockefeller Univ., New York); Threlkeld, S. F. H. Genet. Res., 11: 21-31(Feb. 1968).

Attempts were made to develop mutants in the green, heterothallic alga (Eudorina elegans) by uv and ^{60}Co γ irradiation, as well as by various chemical agents. Cells from log-phase cultures were exposed at a 10-cm distance to a Hanovia lamp (CH 1/988) for 5 to 25 min or to doses of 9000 to 40,000 rad of γ radiation at 100 rad/min. The uv-irradiated cells in the absence of photoreactivation yielded a standard kill curve. Under the experimental conditions used, exposure to uv light for 25 min was found to kill 99.9% of the cells. The survival curve following γ irradiation was linear. A dose of 9000 rad killed only about 30% of the cells, but no cells survived an exposure to a dose of 40,000 rad. A few presumptive mutant colonies were isolated following uv or γ irradiation, but were found to have no specific requirements and showed wild-type growth on minimal agar. No mutant with a specific growth requirement or morphological change was isolated. Wild-type strains were found to be sensitive to different drugs when grown on minimal agar containing very low concentrations of these drugs. Mutant strains resistant to high concentrations of drugs were isolated. These were msr-500 (resistant to 500 μg/ml of DL-methionine-DL-sulfoximine), ery-r-100 (resistant to 100 μg/ml of erythromycin) and sr-100 (resistant to 100 μg/ml of streptomycin). The wild-type phenotypes sensitive to these drugs were designated as mss-500, ery-s-100 and ss-100, respectively. The sr-100 also showed cross-resistance to other antibiotics belonging to the streptomycin group. (BBB)

38242 ISOLATION OF ANEUPLOID LINES IN DURUM WHEAT. Bozzini, A.; Giorgi, B.; Martini, G. (Univ., Pisa, Italy). Genet. Agr., 20: 24-36(1966). (In Italian). (RT/BIO-(67)14).

Cytogenetical analyses of mutant lines of durum wheat isolated after treatment with radiations and chemicals, showed the occurrence of aneuploid individuals. Trisomics, tetrasomics and polysomics were isolated, particularly in progenies showing reciprocal translocations or meiotic disturbances (desynapsis). Since most aneuploids were isolated in mutant lines presenting structural aberrations and strong morphological and/or physiological modifications, a series of backcrosses to Cappelli—the standard line—was considered necessary, in order to establish the aneuploid condition in a normal background. Results of cytogenetical analysis of aneuploid lines following self-fertilization and/or backcross to Cappelli demonstrated: a good transmission of the aneuploid conditions through female gametes and a limited transmission through male gametes; presence of individuals with chromosome numbers ranging from 2n = 29 to 2n = 61 and still showing some fertility; a good frequency of telocentric chromosomes resulting from misdivision of laggards. (auth)

38243 CHROMOSOMAL ABERRATIONS IN PATIENTS SUBMITTED TO THERAPEUTICAL IRRADIATION. Biagini, C.; Brancadoro, P.; Siciliano, A. (University Inst. of Radiology,

Rome). pp 1441-7 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A relatively high percentage of chromosomal abnormalities was observed in patients with tumors about to be submitted to radiation therapy. Aberrations can be attributed mainly to the age, to the effects of radiodiagnostic x rays, and possibly to other factors related to the presence of cancer. Exposure to partial irradiation was followed by a significant increase of abnormalities 24 and 72 hours after doses ranging from 10 to 1,000 rad of γ rays from ^{60}Co on the skin, in a chest field of 10 × 10 cm. In spite of the presence of chromosomal aberrations before the treatment, readings made 24 and 72 hours after partial exposure contained certain quantitative information as far as dose effects were concerned. A significant diminution of percentage of modal cells was obtained against dose, and the total number of aberrations and polyploids increased with radiation dose. The high degree of variability seems to be connected with the presence of abnormalities before irradiation and with the fact that not all cells can be at the first division when the analysis was carried out. Furthermore, it must be remembered that the doses used were relatively small when compared to integral doses or bone-marrow doses obtained with whole-body irradiation or with complete therapeutic treatments. For whole-body irradiation, the approximate equivalent amount of doses would range from a few hundred millirad to 20 to 30 rad when integral doses or bone-marrow doses were considered. Owing to the high degree of variability at present, the findings do not appear suitable for evaluating the dose coefficients for each chromosomal aberration. The total number of aberrations and the proportion of polyploid cells per thousand appear to be the best quantitative expression of the damage induced by radiation in this material, 24 hours after partial irradiation. (auth)

38244 CHROMOSOME ABERRATIONS IN LONG-TERM CULTURES FROM IRRADIATED HUMAN SKIN AND IN BLOOD CULTURES FROM IRRADIATED PATIENTS. Visfeldt, Jakob (Radiumstationen, Copenhagen). pp 1432-4 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Cultures of biopsies taken from human skin were studied in order to determine whether radioinduced chromosome aberrations persist and reproduce in culture. It was found that chromosomes capable of reproduction in cultures were distinct stable forms of aberrations that form part of balanced karyotypes. Blood cultures from cervical cancer patients treated with radium and x radiation were studied. The number of cells with stable aberrations was constant following exposure and the stable aberrations were of the same types as those found in the skin cultures. The number of cells with unstable aberrations was markedly reduced during the first two years following exposure. Results of these studies led to the conclusion that radiation-damaged lymphocytes are able to persist in the blood for many years without undergoing mitotic division. (H.L.W.)

38245 CHROMOSOME CHANGES IN IRRADIATED MEN. Knoerr-Gaertner, Henriette pp 1426-31 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

After diagnostic, therapeutic, or accidental in vivo exposure to radiation, morphological deviations from the norm can be demonstrated over a long period of time by in vivo chromosome analysis. It is a known fact that the radiation-induced chromosomal changes manifesting themselves in basic scientific experiments with animals and plants are principally and qualitatively the same as those observed in exposed humans. It is also known that the correlations existing between the physical factors of radiation exposure and the rate of induced chromosomal changes shown by plant and animal studies can be validly applied to human subjects. Differences that could occur would probably be of a quantitative nature, or could be attributed to the individual deviations in sensitivity to exposure, and the ability to recover. On the basis of modern human cytogenetic studies, the specific significance of this technical branch of radiology in connection with the problems of radiation hazard and protection is briefly discussed. Apart from known numerical and structual radiation-induced chromosomal changes, the problems of the possible somatic and genetic implications, i.e., the effects on individuals and their progeny, are reviewed. (auth)

38246 CHROMOSOME ABERRATIONS IN IRRADIATED HUMANS. Bender, M.; Gooch, P. C. (Oak Ridge National Lab., Tenn.). pp 1421-5 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Methods of determining coefficients of aberration production in human chromosomes are discussed. Results of effects of fission neutrons, γ radiation, and x radiation on chromosomes of leukocytes are presented in tabular form. Chromosome aberrations occurring in human leukocytes following whole-body exposure to plutonium and uranium criticality accidents and a γ ray incident are reported. A study of blood samples over a period of time following exposure revealed that after the third or fourth week, the aberration frequencies fell sharply and decreased slowly thereafter. It was found that a discrepancy between the single- and two-break aberration yields was a measure of dose inhomogeneity. (H.L.W.)

Health Physics and Safety

Refer also to abstracts 37652, 37999, 38049, 38053, 38100, 38109, 38191, 38194, 38218, 38220, 38245, 38255, 38261, 38270, 38283, 38298, 38301, 38304, 38348, 38356, 38368, 38405, 38432, 38456, 38474, 38490, 38509, 38803, 38822, 39501, 39896, and 39896.

38247 (A/AC.82/G/L-1163) CHANGES IN THE QUENCHING EFFECTS OF ANIMAL PLASMA AND SERA WITH THE RADIATION DOSE. El Kharadly, M. E.; Hashish, S. E.; Mahmoud, K. A. (Egyptian Society of Nuclear Sciences and Applications). [1966]. 10p. Dep.

A preliminary study on the changes in the quenching effects of rabbit and rat plasma and sera as a result of total body exposure to ^{60}Co gamma radiation at 50, 100, 150, and 200R was carried out. The experimental results showed that the quenching effects were greater in case of rats than in case of rabbits. They also indicated that the quenching effects were almost identical for plasma or sera samples subjected to the same radiation dose. The results obtained were discussed in the light of relevant literature. (auth)

38248 (AD-664759) EFFECTS OF SURFACE IRREGULARITIES ON RADIATION LEVELS. Foderaro, A.; Kenney, E.; Luckow, T.; Simon, J. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Dec. 1967. Contract DA-18-035-AMC-712(A). 121p. (NUC-E-28). CFSTI.

Scintillation spectrometer pulse height spectra for surface roughness tests were unfolded by the method of N. E. Scofield. After adjusting the data to compensate for some irregularities, exposures as functions of height were computed for each of eight test surfaces. A Monte Carlo model was developed which used an equivalent ground overlayer thickness to simulate surface roughness effects. Monte Carlo results predicted that maximum dose occurs at a lower height than that of the experimental data. A modification of this Monte Carlo program, written to determine what angular dependence, if any, dose had away from a point source at or near the ground surface, showed dose to be roughly a function of the angle which the source-detector line made with the horizontal. Correction factors as functions of this angle were computed. Average doses at three foot heights for all eight test surfaces were extrapolated out to infinite field doses using these angle correction factors and inverse square correction factors. The ratios of these infinite field doses to theoretical uncollided doses from a smooth infinite plane source in an infinite air medium were computed. Reductions of 20 to 25 percent were found for bare, sandy soil, and turf surfaces. Macadam and snow surfaces showed smaller reductions and asphalt, concrete, ice, and glass show experimentally extrapolated doses to be virtually the same as theoretical uncollided doses. (auth) (USGRDR)

38249 (BLG-371) ANALYSIS OF NOSE BLOW SAMPLES FOR THE DETECTION OF ALPHA EMITTERS. Valentin, N. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Apr. 1966. 11p. Dep.

An analytical procedure for the determination of thorium, uranium, plutonium and americium in nose blow is described. Collection of nose blow samples was initiated by the health physicists of AERE, HARWELL. The very interesting relation they found between the plutonium activity of nose blow sample and the plutonium activity found in faecal samples, following an incident, shows the importance of the collection and analysis of such samples. The result of the analysis can be obtained after two hours. (auth)

38250 (CONF-660573) PROCEEDINGS OF THE FIRST CONFERENCE ON LASER SAFETY, MAY 19-20, 1966, AT ORLANDO,

FLORIDA. Flint, Graham W. (ed.) (Martin Co., Orlando, Fla.). 146p.

Four papers with subsequent panel discussions that were concerned with laser safety and hazards are presented; separate abstracts were prepared for each paper. (B.S.L.)

For abstracts of individual papers see: 38251, 38252, 38420, and 38421.

38251 (CONF-660573-, pp 63-84) DERIVATION OF LASER HAZARD CRITERIA. Flint, Graham W. (Martin Co., Orlando, Fla.).

A series of equations were derived whereby the level of retinal illumination could be expressed in terms of laser parameters and viewing conditions. Using these equations the illumination levels for specific sets of circumstances were established. This level was compared with that corresponding to the damage threshold and whether or not a hazardous condition existed was determined. However the use of the equations proved to be quite cumbersome and a simplified approach was indicated. (B.S.L.)

38252 (CONF-660573-, pp 97-109) IMPLEMENTATION OF PROCEDURES AND TECHNIQUES FOR SAFE OPERATIONS OF LASERS. Fine, Samuel (Northeastern Univ., Boston, Mass.).

Personnel duties, medical supervision and records maintenance, and the design of facilities for the safe operation of lasers are outlined and discussed. Protection standards and dosimetry methods and the management of accidents are also discussed. In the ensuing panel discussion, the design, availability, and efficiency of protective attenuators of laser radiation (clothing and eye-protection goggles) are emphasized. (B.S.L.)

38253 (DP-MS-67-99) BIOLOGICAL INDICATORS OF ENVIRONMENTAL RADIOACTIVITY. Harvey, R. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 3, 1968. Contract AT(07-2)-1. 9p. (CONF-680108-11). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Monitoring the uptake of radionuclides by biota in the environs of a nuclear facility is an important part of environmental surveillance because many of these organisms may be in the food web of man. Although each new facility must develop a monitoring program to suit the nature of its releases and its environment, much use can be made of radioecological data developed at existing facilities to determine the kinds of organisms that should be samples. Criteria are discussed for the selection and use of specific organisms to indicate the radionuclide content in various segments of man's food web in the environs of the Savannah River Plant. (auth)

38254 (EUR-3747) PROCEEDINGS OF THE SYMPOSIUM ON MICRODOSIMETRY, ISPRA, ITALY, NOVEMBER 13-15, 1967. Ebert, H. G. (ed.) (European Atomic Energy Community). Jan. 1968. 789p. (In several languages). (CONF-671109). EURATOM.

Thirty-six papers were presented; separate abstracts were prepared for thirth-four. Abstracts of the two remaining papers appeared previously in NSA as 22: 4300 and 22: 6311. (H.G.D.)

For abstracts of individual chapters see: 38049–38054, 38113–38120, 38230, 38307–38319, 38387, 38480, and 38800–38803.

38255 (EUR-3918) MOUVEMENT DE CERTAINS ISOTOPES CHEZ LES ANIMAUX ET CHEZ L'HOMME. Rapport Annuel 1966. (Movement of Certain Isotopes in Animals and in Man. Annual Report, 1966). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 20, 1967. 36p. (In French). Dep.

The research conducted in 1966 continued the work of the previous year on the metabolism of rare earths and plutonium. They revealed the importance of the stability of the bond between the radioelement and its carrier, whether natural or artificial. It is this stability that governs both the secondary distribution in the organism and the degree of elimination. If DTPA is the chelator, it is because it affords the stablest bonds with rare earths and with plutonium. In addition to the foregoing, the removal of cesium-137 from the body with Prussian Blue was also investigated. Lastly, research was conducted on the mechanisms that govern the lung-removal process in three animal species: rats, cats, and monkeys. (auth)

38256 (FOA-4-4354-28) EXPECTED CONTENT OF ^{90}Sr AND ^{137}Cs IN SWEDISH CROPS AND MILK AT A TOTAL DEPOSITION IN THE PLOWLAYER OF 1 Ci ^{90}Sr AND 1 Ci ^{137}Cs PER KM^2. Fredriksson, L.; Eriksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). May 1968. 18p. Dep.

The contents are calculated of ^{90}Sr and ^{137}Cs that can be expected in certain crops and in milk in Sweden. The calculations are made for plant uptake from soil contaminated to 1 Ci of each nuclide per km^2. The calculations are based on actual contents of the nuclides in vegetation and milk in Sweden and on results from extensive tracer studies. (Sweden)

38257 (FOA-4-4357-28) MIGRATION AND PLANT AVAILABILITY OF FISSION PRODUCTS IN A LYSIMETER EXPERIMENT. I. PLANT UPTAKE AND LEACHING OF ^{137}Cs. Fredriksson, L.; Eriksson, A.; Loensjoe, H.; Haak, E. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). May 1968. 26p. Dep.

Results are reported from the first three years in a lysimeter experiment about plant absorption and leaching of ^{137}Cs added to different soils at the start of the experiment. The lysimeter pots were 100 cm deep. The experiment comprises two subsoils, fine sand and clay, combined with three different topsoils. The influence of various amounts of fertilizers was also studied. It was found that plant uptake of ^{137}Cs was influenced much more by the conditions in the upper 25 cm of the soil profile than by deeper layers. Application of complete fertilizers containing ammonium nitrogen enhanced plant absorption of ^{137}Cs with the drainage water varied inversely with crop yield. The content of ^{137}Cs in the drainage water was lower from pots where the subsoil was fine sand than from those where the subsoil was clay. The difference is explained by the more intense interaction between water and soil when the water passed through the homogeneous sandy subsoil than when it passed through cracks etc. in the clay. (auth) (Sweden)

38258 (NP-17119) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 5, Number 8. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Aug. 1967. 43p. (In English and French). Dep.

Data are presented on the total β activity caused by fallout in samples of atmosphere precipitation collected at 24 stations in Canada during July, 1967. Data are also included on the content of ^{137}Cs and ^{90}Sr in the samples of precipitation and in samples of liquid milk obtained from 16 cities during the same month. Results of radiation monitoring in the environs of Canadian Reactors during July, 1967, are also included. (C.H.)

38259 (NYO-3364-42) ^{137}Cs IN PEOPLE AND FOOD IN NORWAY, 1963-67. PART I. Stroemme, Aksel (Norsk Radium Hospital, Oslo). Contract AT(30-1)-3364. 72p. Dep. CFSTI.

A summary of results from analyses of cow's milk samples from 270 dairies in Norway during 1966 is presented. The precipitation in May, June, and July and the total precipitation for the year 1966 were correlated with the ^{137}Cs concentration in milk during the spring of 1967. Results are shown by means of tables and graphs. The composition and variation of the diet of cows in Norway was studied during the years 1062 through 1966. It was determined that the ^{137}Cs content of the meat and milk was a function of the ^{137}Cs content of the diet, and therefore it was concluded that the great differences in concentrations of ^{137}Cs in milk and meat were caused by the differences in the local fallout of ^{137}Cs. Cow's meat was analyzed for ^{137}Cs by gamma spectroceopy during 1964 through 1967, and seasonal variations in the specific activities of ^{137}Cs were found. Highest concentrations were reached during the summer months while the lowest concentrations were found in late winter and early spring. The ^{137}Cs content of meat decreased from 1964 to 1967; however, the decrease in concentration of ^{137}Cs in milk was more pronounced than that of meat. Potatoes and carrots were analyzed for ^{137}Cs during the period 1964 through 1966. A marked decrease from the fall of 1964 to the fall of 1965 was noted. A survey is described of the ^{137}Cs body burden in people of Masfjorden, a small community in the northwest part of Norway where the highest average yearly precipitation occurs. Because of the relatively high ^{137}Cs concentrations in milk and other foods from Masfjorden, studies on the ^{137}Cs body burden in people from this community are of particular interest with regard to radiation exposure to the population from long range fallout. The relatively high ^{137}Cs body burdens are the result of a large amount of radioactive fallout found in most parts of the coastal districts in western and northern Norway. (H.L.W.)

38260 (ORNL-TM-2250) ALGAM: A COMPUTER PROGRAM FOR ESTIMATING INTERNAL DOSE FROM GAMMA-RAY SOURCES IN A MAN PHANTOM. Warner, G. G.; Craig, A. M. Jr. (Oak Ridge National Lab., Tenn.). June 10, 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A brief description of ALGAM, a Monte Carlo computer code for estimating internal dose in a man phantom from a variety of gamma-ray exposure situations, is given. (auth)

38261 (SC-CR-67-2845) BIOHAZARDS OF AEROSPACE NUCLEAR SYSTEMS. Quarterly Report, January 1–March 31, 1967. Clark, T. G.; Fish, B. R.; Boyett, R. H.; Wilkie, W. H.; Royster, G. W. (Oak Ridge National Lab., Tenn. Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract 48-5377. 35p. Dep. CFSTI.

In support of the aerospace nuclear safety program, analytical and experimental studies were made on the potential hazards in the use of $^{238}PuO_2$. These studies included calculations which showed that for a sedentary subject no microsphere of PuO_2 larger than 170 microns could be inhaled into the nose. A computer program was written to determine various fluid dynamical properties of particles having densities from 1 to 12 grams/cm^3. Dosimetric studies included calculations of the α, γ, and neutron dose rates to tissue from the microspheres. Dose rates from the α emission were orders of magnitude higher at close distances than the other radiation emitted. Measurements of the 17 KeV x ray from ^{239}Pu showed greatly decreased transmission through polyvinyl chloride as compared with a plastic material that did not contain chlorine. In manipulating the $^{238}PuO_2$ particles it was discovered that the clean microspheres contaminated the probes, container, and counting equipment with which they come in contact. (auth)

38262 (SC-RR-68-174) LASER EYE AND SKIN HAZARD EVALUATIONS. Burnett, W. D. (Sandia Corp., Albuquerque, N. Mex.). May 1968. 19p. (CONF-680503-5). Dep. CFSTI.

From American Industrial Hygiene Conference, St. Louis, Mo.

Laser eye and skin hazards are evaluated by comparing direct-exposure intensity levels on the surface of the eye or skin to exposure guidelines equal to threshold effect levels where the skin or cornea is affected and conservatively safe levels based on worst case assumptions where the retina is affected. Equations are presented for calculating the exposure intensity when the laser beam parameters and the range are known. Intensity amplification factors of the eye are indicated for the three cases encountered in practice: where simple geometric optics apply, where the laser beam divergence angle is limiting, and where Fraunhofer diffraction effects are limiting. Diffraction effects predict the maximum eye intensity amplification and hence define the worst case for retinal exposure. The resultant exposure guidelines are summarized and estimates made of the associated safety factors. These exposure guidelines quickly identify problem areas that may require more complicated exposure equations and a careful consideration of the actual geometries and safety factors involved. (auth)

38263 (TID-24459) VULNERABILITY OF FOOD CROP AND LIVESTOCK PRODUCTION TO FALLOUT RADIATION. Final Report. Bell, M. C.; Cole, C. V. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Sept. 7, 1967. 34p. Dep. CFSTI.

The effects of radiation on food crops and livestock were reviewed and the relation of these effects to the vulnerability of food production to fallout radiation was assessed and discussed. It was concluded that much more data were needed on the effects of the stage of growth on the β- and γ-radiosensitivity of principal food crops; the retention of fallout by plants and animals; the sensitivity of the gastrointestinal tracts of grazing livestock to fallout radiation; and the effects of radiation on cattle. (B.S.L.)

38264 (UCRL-18140, pp 37-55) BIOASSAY CORRELATION WITH BREATHING-ZONE SAMPLING. Caldwell, Roger; Schnell, Edward; Potter, Thomas (Nuclear Materials and Equipment Corp., Apollo, Pa.).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Nuclear fuel production operators at NUMEC wore battery-powered lapel air samplers for two years. When an exposure occurred, the operator was removed from radiation work and fecal, urine, and nasal contamination measurements were performed. A correspondence between breathing-zone sampling and early-clearance fecal data was observed. Neither urinalysis or fixed-station air sampling was considered to be a reliable method for measurement of personnel exposure. (auth)

38265 (UCRL-18140, pp 103-22) PLUTONIUM CONTENT OF SEVERAL INTERNAL ORGANS FOLLOWING OCCUPATIONAL EXPOSURE. Lagerquist, C. R.; Bokowski, D. L.; Hammond, S. E.; Hylton, D. B. (Dow Chemical Co., Golden, Colo.). (RFP-997).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Tissue samples from several internal organs were analyzed for plutonium following the natural death of an employee of a plutonium production plant. This employee had two contaminated puncture wounds and had several small inhalation exposures over a 9-year period. He had excreted measurable quantities of plutonium in his urine since 1958. A body burden calculation based on these urine results indicated the presence of 13.5 percent of the maximum permissible amount at the time of death. An extrapolation of tissue analysis to the whole body indicated the presence of 2.4 percent of the maximum permissible amount. (auth)

38266 (UCRL-18140, pp 123-43) STUDY OF INDIVIDUAL VARIATION OF EXCRETION OF PLUTONIUM BY MAN AND OF ITS SIGNIFICANCE IN ESTIMATING THE SYSTEMIC BURDEN. Snyder, W. S.; Ford, Mary R.; Warner, Gordon (Oak Ridge National Lab., Tenn.).

The excretion data of 15 terminal patients, who received ^{239}Pu by IV injection was analyzed and studied in the context of the title. Power functions $bt^{-\beta}$ were fitted to the urinary excretion data U(t) by minimizing the sum of deviations and the sum of percent deviations. This corresponded to minimizing the sums $\Sigma_t |U(t) - bt^{-\beta}|$ and $\Sigma_t |1 - U(t)/bt^{-\beta}|$, respectively. This minimization produced parameter values a and α which provide a best fit to an individual's data; and by pooling all the data, one obtains values of a and α for the group. The distribution of the data U(t) of an individual about his own curve of best fit and about the curve determined for the group was studied, and confidence limits P and p were determined so that the data U(t) only exceeded $P\,bt^{-\beta}$ or fell below $p\,bt^{-\beta}$ on a preassigned percentage of days. For example, it appeared from analysis of these data that an individual's daily excretion was between 0.3 and 3 times the power function $bt^{-\beta}$ for the group about 90% of the time. Thus, if a plutonium worker's excretion on a certain day was higher than his previous trend by more than a factor of 3, it could be concluded with a rather high degree of confidence, perhaps 90%, that he had a new intake to blood. If the employee's excretion was high on a certain day, but not by as much as a factor of 3, then it could be concluded that there is a chance of 10% or more than the excess represents only a temporary fluctuation and the postulation that a new intake has occurred is not needed. The same type of analysis was used with the integral form of the power function, e.g., $\int_{t-1}^{t} bx^{-\beta}\,dx = b[t^{1-\beta} - (t-1)^{1-\beta}]/(1-\beta)$ in place of $bt^{-\beta}$. The use of these distributions in estimating body burdens is discussed and illustrated by examples. (auth)

38267 (UCRL-18140, pp 175-95) CONTENT AND DISTRIBUTION OF STABLE STRONTIUM AND ^{226}Ra IN HUMAN SKELETONS FROM WISCONSIN DECEDENTS, 1957–1961. Martin, Alex (Public Health Service, Cincinnati, Ohio).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

A large collection of essentially complete human skeletons provided an opportunity for simultaneous measurement of stable strontium and ^{226}Ra in a group of 75 subjects. The skeletons were from Wisconsin residents who died during the period 1957 to 1961 and whose ages at death ranged from 24 to 95 years (avg ≈ 70 yr). Strontium-90 was not measured because estimated levels on the order of 0.1 pCi/g calcium were too low to permit adequate comparisons, particularly for smaller bone categories. Stable strontium and ^{226}Ra were determined in midsections of the combined tibiae and fibulae from each of the 75 skeletons. Their frequency distributions were found to be log-normal. Concentrations varied from 0.29 to 2.20 mg strontium/g calcium (log-mean = 0.51 mg strontium/g calcium) and from 13 to 112 fCi ^{226}Ra/g calcium (log-mean = 33 fCi ^{226}Ra/g calcium). There was no statistical correlation between strontium and ^{226}Ra levels. To evaluate the relative distribution of strontium and ^{226}Ra within these skeletons, 19 component parts (excluding teeth) from three of the 75 were analyzed. Stable strontium and ^{226}Ra concentrations were found to be nearly uniform within any one skeleton. Although the levels of ^{226}Ra in long bone ends were only slightly higher and the concentrations of strontium slightly lower than in corresponding long bone shafts, the differences were statistically significant. The relationship of these data to reported high levels of stable strontium and ^{226}Ra in certain Wisconsin municipal drinking water supplies is discussed and a comparison of these findings with those from similar studies is given. Descriptions of the analytical techniques employed in the study are included in the report. (auth)

38268 (UCRL-18140, pp 277-88) TECHNO-LEGAL FACTORS TO BE CONSIDERED IN DEVELOPING THE RADIATION DOSE RECORD. Hart, J. C. (Oak Ridge National Lab., Tenn.).

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Methods used in the documentation of procedural techniques for the determination of radiation dose to personnel and the legal factors that affect the credibility of testimony derived from these records and offered as evidence in a court of law are discussed. (B.S.L.)

38269 ^{90}Sr CONTENT OF HUMAN BONES. Voedroes, D.; Koritsanszky, D.; Miklos, K. (Medizinisch-Radiologisches Forschungsinstitut, Budapest). Radiobiol.-Radiother., 8: 571-4 (1967). (In German).

The content of ^{90}Sr in 55 human bones from persons of different ages who had resided in Germany was determined. The samples were tibia and femur. The bone sample was ashed and chemical separation was done by means of concentrated nitric acid. The measurements were performed with counting equipment with low background radiation. Activity was determined on the basis of reference measures that corresponded to the order of the ^{90}Sr content obtained from the samples. Activity of the samples did not show an essential deviation from the values of the international average. (auth)

38270 DETERMINATION OF NATURAL URANIUM IN THE URINE. Zholdosh, T.; Chevari, S.; Tot, A.; Nad, L. Med. Radiol., 11: No. 11, 56-61(Nov. 1966). (In Russian).

A technique is described for determining uranium in the urine of exposed and nonexposed persons. The data obtained are correlated with data on the maximum permissible concentration of uranium in the urine and may be used to monitor the environment and work areas. The temporary transfer of the worker subjected to an increased exposure to a different work is indicated. If such measures are taken it prevents the subsequent disturbances in the organism, thus serving as a prophylactic measure against severe forms of injury. (auth) (TSS)

38271 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BEAMS OF PHOTONS AND OF 20-MeV ELECTRON BEAMS. CHAPTER I. APPLICATIONS OF CHEMICAL DOSIMETERS ($FeSO_4$) FOR MEASUREMENT OF ABSORBED DOSE. Wambersie, A. J. Belge Radiol., Monogr. 1, 14-40(1967). (In French).

The application of $FeSO_4$ dosimetry to the measurement of the absorbed dose for ^{60}Co γ radiation and 20-MeV electron beams is discussed. The response of the chemical dosimeter to irradiation was studied. The calibration coefficients of ionization chambers and of $FeSO_4$ dosimeters were determined. (J.S.R.)

38272 DISTRIBUTIONS AND CALCULATION OF TUMOR DOSE IN GAMMA-RAY CONVERGENT-BEAM IRRADIATION. Ratner, T. G.; Bibergal', A. V. (Inst. of Biological Physics, Moscow). Radiobiol.-Radiother., 8: 587-95(1967). (In German).

Dose distributions in γ ray convergent-beam irradiations were calculated for movement angles of ±30° in both planes, different axial field sizes, and depths of the center of convergence. The method used for calculation of the tumor and surface dose is discussed. (auth) (TSS)

38273 PECULIARITIES OF DOSE DISTRIBUTION FOR MULTI-REGION CONVERGENT-BEAM IRRADIATION IN GAMMA-RAY THERAPY. Ratner, T. G.; Bibergal', A. V.; Palicyna, N. A. (Inst. of Biological Physics, Moscow). Radiobiol.-Radiother., 8: 597-605(1967). (In German).

Various methods of multi-region convergent-beam irradiation with γ radiation and the respective dose distributions are described. Multi-region convergent-beam irradiation proved useful for the treatment of deep-seated malignant tumors. (auth)

38274 THERAPY WITH RADIOGOLD SEEDS, PROGRAMMED DOSE CALCULATION. Moepert, S. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 607-14(1967). (In German).

The use of ^{198}Au seeds for localized radiotherapy offers great advantages compared with radium. The exact dose calculation is very time consuming for the therapist. It is possible by means of computers to determine the individual dose distribution in the radiation zone exactly and rapidly. Patterns of programs for dose calculation, as well as for the planning of implantations, are given. (auth)

38275 IS THERE ANY POLONIUM HAZARD? Parfenov, Yu. D. Med. Radiol., 11: No. 11, 69-75(Nov. 1966). (In Russian).

Studies on the dangers of natural ^{210}Po to humans are briefly reviewed. Results emphasized the hazards to man of inhaling the ^{210}Po in tobacco smoke. Data on the ^{210}Po radiation dose to the bronchial epithelium of persons who smoke cigarettes are presented. (R.V.J.)

38276 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFICIENCY OF 20-MeV PHOTON AND ELECTRON BEAMS. CHAPTER V. CLINICAL STUDIES OF RBE OF HIGH-ENERGY ELECTRONS AND PHOTONS. Wambersie, A. J. Belge Radiol., Monogr. 1, 94-103(1967). (In French).

Clinical data on the RBE of high energy electrons and photons are too slight to permit definitive conclusions on the RBE of x radiation and high energy electrons. However, it can be affirmed that the clinical data available are not in contradiction with radiobiological experiments. The RBE of high energy electrons is not very different from high energy x rays and is about 0.8 to 0.9 with respect to classical x rays. No data suggested the existence of a differential effect with respect to the healthy and tumorous tissues. (tr-auth)

38277 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BEAMS OF PHOTONS AND 20-MeV ELECTRON BEAMS. CHAPTER IV. RELATIVE BIOLOGICAL EFFECTIVENESS OF 20-MeV ELECTRONS COMPARED WITH 21-MeV PHOTONS FOR LETHALITY OF MICE. Wambersie, A. J. Belge Radiol., Monogr. 1, 69-93(1967). (In French).

The RBE of 20-MeV electrons with respect to 21-MeV photons was determined using lethality of mice as the biological test. The biological effects of electrons relative to photons was found to be very close to unity for biological tests consisting of whole-body irradiation: Medullary death in 30 days (0.96 ± 0.025), intestinal death in 4 to 5 days (1.02 ± 0.05 and 1.04 ± 0.03), and the number of splenic nodules (0.99 ± 0.05). The results obtained in the mouse were similar to those obtained in bacteria and yeasts. The relatively slight variations observed in the RBF values as a function of the biological test during electron irradiation resulted from a sub-dosage of a part of the bone marrow because of scattering. This illustrates the difficulty of electron dosimetry in a non-homogeneous medium. (J.S.R.)

38278 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BEAMS OF PHOTONS AND 20-MeV ELECTRON BEAMS. CHAPTER III. PHYSICAL YIELD AND RBE OF 20-MeV ELECTRONS AS A FUNCTION OF DEPTH. Wambersie, A. J. Belge Radiol., Monogr. 1, 53-68(1967). (In French).

The physical yield and the RBE of the 20-MeV electron beam was measured as a function of depth in bacteria (Escherichia coli) and diploid yeasts (Saccharomyces cerevisiae). The results showed no significant variation of RBE as a function of depth in the two biological systems. The doses were determined by means of $FeSO_4$ dosimeters irradiated in the same geometric conditions as the microorganisms and by assuming a constant G value in depth. The study of the yield curves obtained with ionization chambers showed the difficulty of obtaining a correct dose measurement in depths with chemical dosimeters. (tr-auth)

38279 CONTRIBUTION TO THE DOSIMETRY OF THE CZECHOSLOVAK BETATRON. Khol, Frantisek; Trousil, Jaroslav; Sedivec, Miloslav (Inst. of Radiotechnics and Electronics, Prague. Inst. for Studies of Production and Uses of Isotopes, Prague). Jad. Energ., 14: 148-51(Apr. 1968). (In Czech).

An attempt was made to evaluate the intensity and energy of radiation distribution in the room housing the Czechoslovakian 15-MeV betatron. The proper measurements were carried out in 1964–1966 using film dosimeters with filters which were capable of measuring simultaneously radiation doses and energies at 290 positions in the vicinity of the defectoscopic betatron. Data obtained showed that at various distances from betatron focusing and from transluscent objects a heterogeneous ionizing radiation of various energy with primary photons up to 15 MeV and secondary radiation (produced by photon interaction with surrounding mass) appears. Graphical data are included. (tr-auth)

38280 INTRAMEDULLARY DOSE MEASUREMENTS IN THE BEAGLE FOLLOWING WHOLE-BODY 1000-kVp X IRRADIATION. Maillie, H. D.; Quinlan, W. J. Jr.; Mermagen, H. (Univ. of Rochester, N. Y.). Radiat. Res., 33: 512-16(1968). (UR-49-780).

Holes of sufficient size to admit small dosimeters were drilled into several loci within the major bones of an embalmed beagle cadaver. The dosimeters consisted of 5.5 mg of LiF dosimetry powder sealed within polyethylene tubing. The animal was whole-body bilaterally irradiated with 1000-kVp x rays; the results are given in units of rads per 100 R of midline air exposure. The average of the measurements made throughout the ribs was 76.6 rads, while throughout the other bones with thicker walls (and with smaller associated scattering masses) the doses ranged from 66.8 to 71.8 rads. If ionizing radiation acts directly on the hematopoietic centers in bone marrow, then irradiation would result in a more pronounced effect on this function in the ribs than in the marrow of the thicker bones. (auth)

38281 CALCULATION OF THE DOSE DISTRIBUTION FOR ^{60}Co TELETHERAPY WITH A DIGITAL COMPUTER. I. THE METHOD. Fehrentz, Dieter; Kuttig, Helmut; Braun, Gerhilt (Univ., Heidelberg. Institut fuer Dokumentation, Information und Statistik, Heidelberg). Strahlentherapie, 135: 186-92(Feb. 1968). (In German).

A method is described for calculation of dose distributions in telecobalttherapy with a digital computer. The dose distribution for stationary fields with normal incidence was represented analytically. Also it was possible to calculate, by transformation of the coordinates on the contour of the patient, the contribution

of the various fields and for moving beam therapy. Correction was done for oblique incidence, tissue inhomogeneities and for wedge filters with constant angles. The method of coordinate transformation was limited to beam axis all lying within the same plane. However, dose distribution in parallel planes and in perpendicular planes to the central beam could be calculated. (auth)

38282 IMPROVED EXPOSURE AND PROCESSING TECHNIQUES IN DENTAL RADIOLOGY. Reid, J. A. J. Can. Dent. Ass., 33: 474-86(Sept. 1967).

Means by which dentists can reduce x-ray exposure of their patients and themselves are presented. It is shown how the dentist can check the collimation and filtration characteristics of his own x-ray machine and evaluate his exposure and development techniques. Gonadal radiation can be reduced by diminishing the beam size to $2\frac{3}{4}$ inches dia, using filtration equivalent to 2 mm Al, employing the fastest film, and using a long open-end tube instead of the short cone. Precautions for avoiding exposure to scattered radiation are outlined and suggestions are offered for proper viewing of the radiograph. Tables are presented showing the filtration and collimation characteristics of various x-ray machines. (BBB)

38283 DECREE NO. 66-450 OF JUNE 1966 CONCERNING NUCLEAR ENERGY AND SPACE, WITH REGARD TO THE GENERAL PRINCIPLES OF PROTECTION AGAINST IONIZING RADIATIONS. Int. Dig. Health Legislation, 18: 106-15(1967).

This Decree applies to all activities involving the production, processing, handling, use, storage, transport or disposal of natural or artificial radioactive substances. It lays down equivalents for maximum allowable doses (external radiation and internal contamination) and general principles relating to protection and inspection (supervision of workplaces, ban on employment of workers under 18 years old, special medical supervision of persons occupationally exposed to radiation, etc.). (Occup. Safety and Health Abstr.)

38284 SERUM ZINC LEVELS FOLLOWING EXPOSURE TO IONIZING RADIATION. Quaife, M. A.; Ogborn, R. E. (Veterans Administration Hospital, Omaha, Neb.). Proc. Soc. Exp. Biol. Med., 126: 377-9(Nov. 1967).

The possibility that the content of Zn in blood can be used as an indicator of exposure to ionizing radiation was investigated in dogs. Baseline Zn levels in plasma were determined by spectrophotometric analysis after complexing with diphenylthiocarbazone. After exposure to γ radiation doses ranging from 100 to 600R, plasma samples taken at 6, 12, 18, 24, and 108 hrs were analyzed for Zn content. Results showed an elevation of plasma Zn levels during the day of exposure to doses of 200 R and above and return to control levels by 108 hr postexposure. Although no linear dose response relationship was found between groups in the study, the highest radiation dose elicited the maximum elevation of the serum Zn level that was sustained for a longer period of time. (C.H.)

38285 PROBLEMS OF THE CLINICS AND THERAPY OF HEMANGIONATA IN CHILDHOOD. PART IV. THE QUESTION OF GONADAL LOADS IN THE TREATMENT OF HEMANGIOMATA IN CHILDHOOD. Bek, Vaclav; Michal, Vojtech; Kolar, Jaromir; Trhlinova, Gabriela (Charles Univ., Prague. Forschungsinstitut fuer Strahlenhygiene, Prague). Strahlentherapie, 135: 285-90 (1968). (In German).

Measurements were made in a water phantom to determine the exposure to the gonads during a short source skin distance irradiation by van der Plaats in small children with hemangiomata. The manner in which the gonadal dose in both sexes changed with distance of the radiation source from the gonads, field size, radiation quality, direction of the beam and use of a covering was investigated. The use of soft rays (50 kV) in the area of the lower trunk and at the proximal parts of the lower extremities resulted in a significant gonadal dose under common conditions for radiotherapy of hemangioma. When the area of the head was irradiated, the exposure of the gonads was very low. Finally, the principles of radiotherapy of hemangiomata in children is discussed in regard to the genetic hazards of radiation exposure. Irradiation with soft rays (Dermopan, apparatus by van der Plaats or Chaoul) required a consideration of all factors that influence the radiation exposure of the gonads via scattered radiation. It was justifiable to exclude all external gamma-sources (radium and artificial radionuclides) from radiotherapy of hemangiomata in children. Implantation of gamma-irradiators should only be done in those cases in which all other treatment methods, including surgery, do not give satisfactory results. (auth)

38286 PHYSICIAN AND RADIOLOGICAL DIAGNOSIS. Demulder, R. Acta Tuberc. Pneumol. Belg., 57: 237-62(1966). (In French).

Definitions and a review of the relevant Belgian statutory provisions on the use of x-ray apparatus are presented. Various aspects of radiation protection including operating permits, maximum permissible doses, dosimetry, monitoring or radiological protection, and medical supervision of workers are discussed. The effects of ionizing radiation on man are reviewed and the hazards, applications, and correct use of various techniques of radiological diagnosis (radiography, radiophotography, and radioisotope scanning) are discussed. (Occup. Safety and Health Abstr.)

38287 ^{210}Po CONTENTS OF PLANT TISSUE AND THE USE OF METAL AMMONIUM PHOSPHATES AS VEGETABLE CROP FERTILIZERS. Erhardt, Wilfred Henry. Madison, Wis., Univ. of Wisconsin, 1966. 157p.

Thesis.

Methods for the determination of ^{210}Po in plant tissues were evaluated. Several samples of the edible portion of vegetables (fresh), cured and uncured (green) tobacco leaf tissues, and other dead plant materials were analyzed for ^{210}Po content. Although detectable amounts of ^{210}Po were not found in the fresh vegetables and green tobacco leaf samples, significant amounts were found in cured leaf tobacco, dead bluegrass, tree leaf, and alfalfa samples. Substantial quantities of ^{210}Po were found in all the soils tested. The soil organic matter and ^{210}Po contents were highly correlated, but the plant and soil ^{210}Po contents were not related. Therefore, it was concluded that accumulation of ^{210}Po in vegetative materials must occur after the plants die. Greenhouse and field studies were conducted to evaluate metal ammonium phosphates as vegetable crop fertilizers. (Diss. Abstr.) (TSS)

38288 EQUIVALENT DOSE AND UNITS FOR ITS MEASUREMENT. Yudin, M. F. Izmer. Tekh., No. 11, 15-17(1966). (In Russian).

A change in the present practice of expressing the relative biological effect (RBE) of both quantum and corpuscular radiation in the form of a ratio based on quantum radiation (x rays) alone was suggested. Two modifications were necessary namely: introduction of a quality factor (QF), uniquely characteristic of each type of radiation, to take care of the difference in biological effect of identical doses of various kinds of radiation; and the basing of all calculations on the absorbed tissue dose (expressed in rads) rather than on the external radiation dose (exposure) in roentgens. The precise values of the quality factors for various kinds of radiation would need to be established by worldwide research. A table of approximations was given. It was suggested that the present concept of biological (RBE) dose, expressed in ber units should be restricted to biological objects other than man. In its place all research on shielding and human radiation safety (i.e., studying radiation effects on man) should use the equivalent dose. Equivalent dose would correspond to (but not precisely equal) the product DK, where D was the tissue dose in rad, and K was the quality factor applicable to that type of radiation. Equivalent dose (ED) would be expressed by the unit equivalent rad (eq. rad). (auth)

38289 DECONTAMINATING SOLUTION FOR PLASTIC AND LACQUER SURFACES CONTAMINATED WITH RADIOACTIVE NUCLIDES. Otto, R.; Rabold, H. (Inst. fuer Angewandte Radioaktivitaet, Leipzig. VEB Kombinat Kernergetik, Berlin). Kernenergie, 11: 74-6(Mar. 1968). (In German).

For the decontamination of plastic and lacquer surfaces contaminated with radioactive nuclides, an aqueous solution containing detergents and complexing agents is recommended which does not attack the surfaces even after repeated treatment of the materials. The total content of reagents in the solution is 5.5 and 5.0 g/l, respectively. (auth)

38290 UMWELTRADIOAKTIVITAET UND STRAHLENBELASTUNG. BERICHT I/67. (Environmental Radioactivity and Radiation Burden. First Quarterly Report, 67). Bad Godesberg, Ger., Bundesminister fuer Wissenschaftliche Forschung, 1967. 191p. DM 11,-.

The content of radioactive materials in the air, water, soil, and foodstuffs and the radiation burden of the population in the German Federal Republic measured during the first quarter of 1967 are reported in graphic and tabular form. (H.L.W.)

38291 MEASUREMENT OF THE ^{90}Sr CONTENT OF HUMAN BONE SAMPLES. Vodros, Daniel; Koritsanszky, Denes; Miklos, Katalin. Kiserl. Orvostud., 19: No. 1, 79-81(Jan. 1967). (In Hungarian).

The ^{90}Sr contamination of 55 bones taken from humans of different ages was measured. The samples were taken from the right tibia and femur; they were ashed and the Sr was separated by a chemical method. The measurements were carried out with a self-made, low background counting installation. The values

obtained were also checked standards. According to the measurements, the ^{90}Sr level is in agreement with the concentrations reported in the literature. (CFSTI)

38292 ACCUMULATION OF ^{90}Sr INTO HUMAN FETAL TEETH AND BONE. Rosenthal, Harold L.; Austin, Shirley A.; Gilster, John E.; Bird, John T. (Washington Univ., St. Louis). Proc. Soc. Exp. Biol. Med., 125: 493-5(June 1967).

The ^{90}Sr content of mandibular bone and tooth buds of 73 fetuses aborted in the St. Louis metropolitan area between 1961 and 1966 was correlated with the mother's dietary intake of the nuclide. The data obtained during increasing and decreasing periods of fallout may be expressed by a linear equation, $C_B = K\,C^{M}_{D-4}$, where C_B is fetal bone $^{90}Sr/g$ Ca, C^{M}_{D-4} is the mother's dietary ^{90}Sr intake for the first 6 months of pregnancy, and K is a constant equal to 0.21. The equation is useful to calculate the amount of ^{90}Sr accumulating in fetal calcified tissues from known milk ^{90}Sr values or conversely, to obtain data concerning the mother's dietary ^{90}Sr intake when fetal ^{90}Sr values are known. (auth)

38293 POPULATION EXPOSURE RISK FROM RANDOM RE-ENTRY OF ISOTOPIC POWER DEVICES. Anno, G. H.; Easton, C. R. (Douglas Aircraft Co., Santa Monica, Calif.). pp 130-7 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Assessment of the population exposure risk, for isotopic power devices in space, is based on a possible release of radioactive material at, or after, impact following random re-entry from a circular earth orbit. Exposure risk is calculated on a per curies basis using ^{238}Pu and ^{90}Sr as reference source materials. Risk is determined in terms of dose probability for individuals in the general population. Orbital inclination, population density distribution, ground level atmospheric stability variation, and impact probability are also considered. (auth)

38294 LABORATORY PROGRAM FOR HEALTH PHYSICS SUPPORT OF AEROSPACE OPERATIONS. Odland, Lawrence T. (Radiological Health Lab., Wright-Patterson AFB, Ohio). pp 138-9 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

Increased use of radioactive materials and ionizing radiation in operational and developmental aspects of aerospace technology has created a need for a much more sophisticated health physics support program. The USAF recognized this requirement several years ago and developed a laboratory to support health physicists and bioenvironmental engineers on a world-wide basis. The USAF Radiological Health Laboratory (AFLC), Wright-Patterson AFB, Ohio, is equipped and staffed to provide any Air Force group with all types of analytical and consultation services in the field of health physics. (auth)

38295 NEW DECONTAMINATION AGENTS. Svehla, Pavel. Chem. Listy, 62: 587-90(May 1968). (In Czech).

Two new decontamination agents were developed, Desorb 10 and 20, whose aqueous solution is specific for surface removal of radioisotopes. Their efficiency was compared with that of other materials used for this purpose and its dependence on pH or concentration investigated. The weakly alkaline solution of Desorb 10, which is especially effective for removal of yttrium and rare earths, showed no corrosive effects and is therefore also suitable for decontamination of persons. Desorb 20, since it forms an acidic, slightly corrosive solution, can be handled safely in solid form. (tr-auth)

38296 THE USE OF COMBINED (FLUORESCENT AND TRANSISTOR) DETECTORS IN CLINICAL DOSIMETRY. Glezin, F. I.; Kolotilova, V. G.; Krongauz, A. N.; Lyapidevskii, V. K.; Titov, A. A. (Moscow Scientific-Research Inst. of Roentgen-Radiology). Med. Radiol., 13: No. 2, 14-19(1968). (In Russian).

The paper presents studies of dosimetric characteristics of combined (fluorescent and transistor) detectors for the measurement of doses of x ray and gamma radiation in the air and phantom. A combination of scintillator CsI (Tl) and silicon transistors with p-n transition enables to augment significantly the sensitivity of the detector, as well as to elaborate isotopic detectors necessary for phantom and cavitary measurements. (auth)

38297 CALIBRATION OF A WHOLE-BODY RADIOACTIVITY COUNTER FOR THE MEASUREMENT OF BODY POTASSIUM CONTENT IN CLINICAL STUDIES. Hughes, D.; Williams, R. E. (Univ. of Leeds, Eng.). Clin. Sci., 32: 495-502(June 1967).

A simple formula, using calibration factors based on height and wt, was described for the estimation of the whole-body K content of human subjects from measurements of the γ radiation emitted by the naturally occurring ^{40}K isotope. The formula was of the form: Whole-body potassium = a exp $b(W/H)^{\frac{1}{3}} \times$ (net ^{40}K count-rate) where a and b were constants and W and H were wt and height respectively. Following oral administration of ^{42}K, the response of the counter to ^{42}K became independent of further redistribution after about 12 hr. Following intravenous administration, distribution of ^{42}K was adequate after about 5 hr. At these times, full metabolic equilibrium of ^{42}K would not be expected, but distribution was adequate for calibration of this particular whole-body counter. The actual value of the distribution time depended to a large extent on the geometrical variation in the response of the particular array of detectors used. The values for the constants were determined to give: f = 3.32 exp (1.29 $(W/H)^{\frac{1}{3}}$) where W was in Kg, H was in cm, and f in grams K per counts/sec net count rate. The method was very convenient for use in clinical studies as it eliminated the need for the administration of radioactive substances to the patient for calibration purposes. (BBB)

38298 MEDICAL CONSIDERATIONS AND GUIDE LINES ON PERSONNEL DECONTAMINATION AND DECORPORATION. II. DECORPORATION. Moehrle, G. (Kernforschungszentrums, Karlsruhe, Ger.). Atompraxis, 14: 201-4(Apr.-May 1968). (In German).

Semi-annual examinations of personnel in areas containing radioactive materials were conducted routinely with the Human Body Counter. Additional examinations were conducted in cases of extensive external contamination, high-energy beta ray, or gamma ray incidents. In cases of suspected plutonium incorporation an examination with the plutonium lung counter was conducted. Separation analysis of the following radioisotopes was conducted routinely: americium, carbon-14, plutonium, strontium-90, tritium, and uranium. In determining mechanisms of radioisotope incorporation the following criteria are significant: effective half-life, type of radiation emitted, absorption pathway, and type of distribution in the body. The chief pathways of absorption are through the gastrointestinal tract, respiratory tract, skin, and contaminated wounds. Absorption of plutonium and strontium by the lungs is discussed. The therapeutic possibilities of metal ions and chelating agents are reviewed. An outline of treatment possibilities is presented. General measures for treatment of the gastrointestinal tract are outlined and special measures for cesium, strontium, and rare earths are described. The recommended treatment for the respiratory tract is washing with 3% citric acid. Treatment of skin injuries includes cleansing of the wound, decontamination, and surgery. (H.L.W.)

38299 SCATTERED RADIATION FIELDS AROUND DENTAL X-RAY MACHINES. Paris, N. F.; Williamson, B. D. P. (National Radiation Lab., Christchurch, N. Z.). N. Z. Dent. J., 63: 271-9(Oct. 1967).

The presence and intensity of scattered radiation during the use of dental x-ray machines were pointed out by demonstrating this radiation in the form of isodose curves and by examining the relation between the intensity of scattered radiation and the distance from the patient. It was then shown how these factors affected the radiation dose received by the dentist. A hardboard phantom head, that was previously shown to scatter radiation in much the same way as a human head, was used as a source of scattered radiation. The intensities of scattered radiation around the phantom head were measured in horizontal and vertical planes with an ionization-type radiation survey meter that was calibrated for this type of radiation. The scattered x-radiation fields for two common x-ray machines, used during bitewing radiography, were shown in the form of isodose curves. The interpretation of these curves in terms of average weekly radiation dose to the dentist was discussed. The findings confirmed the value of the National Radiation Laboratory recommendations that, for bitewing radiography, the dentist should stand at least 4 to 6 ft from both the tube and the patient, and never in the direction of the primary x-ray beam. The isodose curves revealed an inverse square relation between the reduction in intensity of scattered radiation and distance from the patient. (BBB)

38300 MEAN ABSORBED DOSES IN THE BODY OF PATIENTS DURING INTRATISSULAR ADMINISTRATION OF ^{198}Au. Linchevskaya, G. A. (Moscow Scientific Research Inst. of Roentgen-Radiology). Med. Radiol., 13: No. 5, 84-91(May 1968). (In Russian).

Methods are discussed for calculating mean absorbed radiation doses in the body of patients depending on the introduced activity of the ^{198}Au-labeled preparation and focus of localization. The necessary formulas for dosimetry during therapy are presented. In order to assess the mean absorbed dose a calculation of dose in the body of standard man (weight 70 kg; height 170 cm) was done. Data from this calculation are presented in the form of tables. (auth)

38301 OCHRONA PRZED OPADEM RADIOAKTYWNYM W ROLNICTWIE. (Protection Against Radioactive Fall-Out in Agriculture). Starzycki, S. (ed.). Warsaw, Panstwowej Wydawnictwo Rolnicze i Lesne, 1966. 264p.

Nine articles are included on the effects of fallout in agriculture and on measures against contamination of dairy products, livestock, soil, and crops. Topics included are: effects of fission products on soil plant relations; ^{90}Sr contamination of milk, cattle, and human bones; effects of nuclear explosions on livestock; influence of stable strontium on ^{90}Sr uptake by plants; assessment of damage to livestock from radioactive fallout; and chemical methods of protection. (H.L.W.)

38302 STUDY OF THE NATURAL RADIOACTIVITY OF MAN. Gabuniya, R. I. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 5, 77-84(May 1968). (In Russian).

Results are presented from measurements of the content of natural isotope radioactivity in the organism of 804 healthy persons, aged 3 to 80 years, carried out in 1965 and 1966. The measurements were conducted in a protective chamber by means of four scintillation counters. Data relevant to the level of ^{40}K and ^{137}Cs were compared with age-specific anatomo-physiological peculiarities of the human development. The potassium level fluctuated in the organism depending on the sex, age, and physical development. The maximal potassium content was noted in childhood (in 7 to 12 year-old girls 2.55 ± 0.17 gm of ^{40}K/kg body weight; in boys 2.93 ± 0.12 gm of ^{40}K/kg body weight), minimal in persons over 55 years (in women 1.38 ± 0.07 gm ^{40}K/kg body weight; in men 1.83 ± 0.11 gm ^{40}K/kg body weight). The level of ^{137}Cs in the organism was not high in comparison with data obtained during 1963. The average level in men was 68.31, and in women 60.81. (auth)

38303 CHOICE OF DOSES IN RADIOIODINE THERAPY OF PATIENTS WITH DIFFERENT FORMS OF THYROTOXICOSIS. Livergant, Yu. E. (Kharkov Inst. of Medical Radiology). Med. Radiol., 13: No. 5, 37-43(May 1968). (In Russian).

Iodine-131 was used to treat 250 patients with hyperthyroidism; the therapy was based on a definite absorbed dose. Twofold better results were obtained in comparison with the therapy of 512 patients receiving the isotope at a dose of 0.1 to 0.15 mCi per gram of thyroid tissue. In some cases a dose of 600 rad did not cause even a weakening of thyrotoxicosis intensity, whereas another dose of 5000 rad exerted a surplus dose that led to the development of hypothyrosis. The most radioresistant cases proved to be the thyroid gland of patients with severe thyrotoxicosis and a large goiter. Upon analysis of the data involving the use of a multicoordinant table, the most expedient doses for the treatment of thyrotoxicosis in different forms of the disease were determined. (auth)

38304 STUDIES ON RADIOACTIVE CONTAMINATION OF THE HUMAN POPULATION. Jammet, H. P. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 1514-21 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

General studies on contamination of the environment included considerations of the physical environment, biological environment, and the food chain. Observations on radioactive fallout were limited to ^{131}I, ^{90}Sr, and ^{137}Cs, and studies on food products were limited to milk, cereals, and meat. Experimental studies in agronomy were concerned with the transfer of radioactivity from the atmosphere to plants, from soil to plants, from plants to animals, and from water to plants. Studies on radioactive contamination of the human population from nuclear testing, from accidents and reactor effluent, and from ingestion of contaminated food were made. Emphasis was placed on nutritional, physiological, and anatomical studies. General techniques for calculation of the level of food and human contamination are discussed. Methods for dose calculations of contamination with a single or several radionuclides are discussed. (H.L.W.)

38305 ^{90}Sr IN HUMAN BONE, JULY-SEPTEMBER 1966. Radiol. Health Data Rep., 8: 403-5(July 1967).

To obtain data on the concentration of ^{90}Sr in man by age and geographical region, the Public Health Service began collecting human bone specimens in 1961. The target population includes children and adults up to 25 years of age. Since ^{90}Sr in measurable amounts has been present in the global environment for more than a decade and major calcium accretion ceases by age 17 or 18, persons over 25 years old are of limited interest in the program. For analytical purposes, a sample of at least 100 grams of wet bone is desired. Most specimens received to date are vertebrae and ribs. Efforts to collect long bones for comparison of results with British data were not successful. (E.R.B.)

38306 PHOTOGRAPHIC TECHNIQUE FOR LEAK TESTING RADIUM SOURCES. Benrosian, Paul H. (Public Health Service, Montgomery, Ala.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 207-12(Jan. 1968).

The photographic method provides a simple, positive, and economical means by which radium sources may be regularly and frequently tested for radium leakage and contamination by the user. In this manner, badly leaking sources may be discovered before they cause widespread contamination of buildings, storage facilities, or other areas where radium-226 is stored or used. Because of its versatility, its rapid operation, and ease of use, the photographic technique represents a safe, effective system which can be used by medical and radiation control personnel for protecting physicians, patients, and others against unnecessary radiation exposure. (auth)

38307 FUNDAMENTAL RELATIONSHIPS BETWEEN LINEAR ENERGY TRANSFER, ABSORBED DOSE, KERMA, AND EXPOSURE. APPLICATION TO CHANGES OF MEDIUMS. Joffre, H.; Pages, L. (Centre d'Etudes Nucleaires, Saclay, France). pp 733-78 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In French).

See EUR-3747; CONF-671109.

After briefly defining the quantities used in dosimetry and presenting them with a view to their adaptation to health physics problems, simple mathematical relationships are established to express the absorbed dose, kerma and exposure in the case of electrons and photons, and also relationships between these quantities considered in air. Variations in these quantities are determined at the interface between the air and the soft tissues of the organism and in depth in the tissues. Numerical values are given of the discontinuities liable to appear at the interface and the values obtained, relative to air, after electronic equilibrium is established in depth in the tissues. An example of application to dosimetry is also given in the case of an aluminium-walled ionization chamber. To conclude, the conditions to be fulfilled in order to make a direct measurement of the absorbed dose in the tissues are presented and discussed. (auth)

38308 DOSIMETRY AT INTERFACES WITH SPECIAL REFERENCE TO BONE. Spiers, F. W. (Univ. of Leeds, Eng.). pp 473-508 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

The problems of dosimetry at interfaces will be discussed with special reference to the nature and structure of bone. The location and radiosensitivity of tissues likely to be relevant to long-term radiation effects in bone will be first considered before reviewing the work so far done in determining the dose to tissues within and adjacent to bone. Problems associated with dosimetry in trabecular bone are considered in greater detail, and new principles of describing the physical dimensions in trabecular bone and of calculating the relevant doses are given. Calculations relating to external irradiation of bone and to irradiation from internal beta emitters are briefly reported to indicate the present position and future trends in this field. (auth)

38309 MEASUREMENT OF LINEAR PATH LENGTH DISTRIBUTIONS IN BONE AND BONE MARROW USING A SCANNING TECHNIQUE. Darley, P. J. (Univ. of Leeds, Eng.). pp 509-26 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

A new approach to the theoretical radiation microdosimetry of trabecular bone requires relevant mensuration data in terms of path-length distributions through both the trabeculae and the marrow cavities. A photoelectric object-plane scanning system that was developed for measuring such distributions either in thin bone sections or on photographs of bone is described. The apparatus provides a means for extensive investigation of the variation in trabeculation with both age and anatomical location. (auth)

38310 THERMOLUMINESCENCE METHODS APPLIED TO DOSIMETRY IN TRABECULAR BONE. Zanelli, G. D. (Univ. of Leeds, Eng.). pp 527-59 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

Two 3.0 mm thick transverse sections of human lumbar vertebrae, with different trabecular structure were cut and washed clean of marrow. The marrow spaces and the trabecular thicknesses were measured by two different methods. In preliminary experiments one of the specimens was filled with LiF (Con-Rad LiF type 7) and irradiated with filtered x rays of three effective

energies and ^{60}Co γ rays. Further experiments were later carried out using finely ground LiF of mean particle size 2.3μ, filtered x rays as above, fluorescent x rays from five secondary radiators, covering the range from 22 to 100 keV and ^{60}Co. After irradiation the LiF was recovered and the mean marrow dose determined. A higher mean marrow dose was obtained for the specimen with the smaller cavities, and the results agree reasonably well with calculations by Spiers based on the concept of a distribution of path-lengths in trabecular marrow. Similar methods were applied to sections of a femur of a beagle dog that was raised on a diet containing ^{90}Sr. The concentration of $^{90}Sr + ^{90}Y$ in the sections was determined. Values of D/D_0 for shafts and mean marrow doses for trabecular bone were derived and compared with experimental data. Current experiments use these methods to determine the mean marrow dose in specimens of human vertebrae artificially loaded with β emitters of a wide range of energies. (auth)

38311 ENERGY TRANSFER OF ALPHA EMITTERS TO THE SOFT TISSUE IN CYLINDRICAL BONE CAVITIES. Sengpiel, W.; Booz, J. (EURATOM, Ispra, Italy). pp 551-68 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

A proportional counter with a length of 1 m and a diameter of 6 cm is used to measure the energy transfer to soft tissue of alpha emitters that are adsorbed at the bone surface of canaliculi, osteocytes, and Haversian canals. Values on the relation between the specific activity and the dose are presented, and the dose distributions in the cylinder are discussed. (auth)

38312 METHOD FOR CALCULATING THE DOSE OF INCORPORATED BETA-EMITTERS IN APPROXIMATELY SYMMETRICAL MICRORANGES. Kuhn, W. (Technische Hochschule, Hanover). pp 583-602 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In German).
See EUR-3747; CONF-671109.

In assessing the radiation burden of incorporated and homogeneously distributed beta-emitters, the average energy of the spectrum is generally taken in place of the actual energy spectrum itself. Thus the weighting of the different energies is not taken into account. If complete absorption occurs inside the substance, i.e., when the body dimensions are large in comparison with the maximum range of the beta-emitter, this is justifiable; but when labelling smaller biological objects, which are sometimes only a few 10^{-4} cm and below, the maximum ranges of even the low energy beta-emitters are considerably greater than the extent of the objects. Complete absorption thus does not occur. We therefore give a method for the calculation of the absorbed energy for approximately symmetrical microranges, taking into account both the energy spectrum of the beta-emitters and the dimension of the region. In the energy range between 1 and 100 keV, the LET-values for tissues are presented as a power function of the energy with negative and non-integral exponents, so that numerical calculation of the absorbed energy in these ranges is possible. (auth)

38313 ION-DOSE CURVE AT INTERFACES. Drexler, G. (Gesellschaft fuer Strahlenforschung mbH, Munich). pp 433-46 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In German).
See EUR-3747; CONF-671109.

The curve for the ion-dose at the boundary surfaces of substances of different composition during irradiation with x- and γ-rays was determined by means of a suitable ionization chamber. In particular, the dependence of the build-up effect upon the radiation geometry at air-tissue boundary layers is demonstrated, and the curve for the ion-dose at tissue-bone transitions studied. Irradiations were performed in the Bremsstrahlung-range between maximum energies of 100 keV and 17 MeV. The dose relations at boundary layers can be calculated from the number and range of secondary electrons. An example with Al-Cu-Al shows good agreement with the measured values. (auth)

38314 IMPORTANCE OF SECONDARY PARTICLE EQUILIBRIUM FOR NEUTRON IRRADIATIONS OF CULTURED CELLS AND INTACT ORGANISMS. Broerse, J. J.; Barendsen, G. W. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). pp 353-83 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

At interfaces of tissues of different composition in intact organisms local perturbations of charged particle equilibrium occur, which may be different for irradiations with fast neutrons and electromagnetic radiation. The variations in absorbed dose at the interface of bone and soft tissue were investigated with a cell culture system. For x irradiations and 15 MeV neutron irradiations survival curves were determined for cells irradiated on muscle-equivalent plastic and on bone-equivalent plastic. Results were related to the bone-marrow and intestinal syndromes in mice after neutron and x irradiation. Because of the various types of interactions of fast neutrons with the components of tissue, the distribution of the dose in LET is complex. It is therefore difficult to assess an average LET for the different types of fast neutrons. An exact knowledge of the relevant distributions of dose in LET is required. For a first approximation a distinction has been made between a high-LET component and a proton component. In order to separate these components experimentally, irradiations were carried out in which perturbations of charged particle equilibrium were induced artificially. Survival curves were determined for neutron irradiations with either layers of tissue-equivalent plastic or layers of pure carbon mounted in front of the cells. These results will be discussed in relation to the OER and RBE values measured for fast neutrons of different energies. (auth)

38315 CALCULATION OF THE BUILDUP OF DOSE IN TISSUE IRRADIATED BY HIGH ENERGY NEUTRONS AND PROTONS. Wright, H. A. (Oak Ridge National Lab., Tenn.). pp 409-12 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

The distribution of absorbed dose and dose equivalent with depth in a tissue slab were calculated for irradiation by normally incident and isotropically incident protons and neutrons in the energy range 0.4 to 2.0 GeV. The calculations take into account the production of pions as well as nucleons in the cascade process, and the energy deposited as a result of ionization by charged particles is separated into LET ranges permitting different quality factors to be used. The total dose is broken down to show the contribution by primary particle ionization (in the case of incident protons), ionization by secondary particles, ionization by pions, excitation of residual nuclei following cascades, and the absorption of pions that stop within the tissue. There is a rapid buildup of dose near the surface and then a more gradual buildup in the remainder of the 30-cm thick tissue slab. Graphs show the distribution of absorbed dose and dose equivalent with depth within the phantom for incident energies 0.4, 0.6, 1.0, 1.5, and 2.0 GeV. (auth)

38316 DEPENDENCE OF THE BIOLOGICAL EFFECTIVENESS OF RADIATION ON PHYSICAL FACTORS OF RADIATION QUALITY, AND THE SIGNIFICANCE OF SUCH DEPENDENCE. Neary, G. J. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). pp 205-48 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

Different biological systems usually depend in different ways on any chosen physical parameter of radiation quality. No unique index of quality universally applicable in all radiobiological circumstances can be defined; physical and biological factors are interdependent. Therefore, in the investigation of fundamental radiobiological mechanisms, the physical factors should be kept as simple as practicable; the use of broad spectra of radiation quality increases the difficulties of interpretation. Examples are given of the complications that can arise. In certain biological systems track-length is an important index of radiation quality. In general, an effective mean value of a parameter of quality may depend on biological and environmental factors such as the presence or absence of oxygen. (auth)

38317 RELATIVE BIOLOGICAL EFFECTIVENESS AS A FUNCTION OF LINEAR ENERGY TRANSFER. Barendsen, G. W. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). pp 249-67 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

Relations between RBE and LET of heavy charged particles for impairment of the reproductive capacity of cultured mammalian cells are discussed. Experimental measurements were made in systems in which the LET was varied either by modification of the velocity of the ionizing particles or by using different ions of the same velocity. Differences between the two relations are mainly attributable to different contributions of δ-rays. Significant differences between RBE-LET relations were reported in the literature for bacteriophages, microorganisms and mammalian cells. The differences are explained by local requirements for energy concentrations in some small part of a critical site or structure in the cells investigated. The highest concentrations of energy

density are required in mammalian cells. These differences between the RBE-LET relations of the different organisms might be related to the complexity of the genetic apparatus. (auth)

38318 IMPORTANCE OF MICRODOSIMETRY FOR RADIATION BIOLOGY AND RADIATION PROTECTION. Barendsen, G. W. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). pp 1-26 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

Relations between biological effects produced by ionizing radiations and the spatial distributions of energy deposition of these radiations are discussed. Effects produced by high-LET radiations are generally found to be less dependent on dose-rate, dose-fractionation and on the influence of cellular conditions and of various compounds in the cell environment, than effects of low-LET radiations. Relations between the relative biological effectiveness of ionizing radiations and the distributions of local energy densities provide information required to test various hypotheses for radiobiological mechanisms. This is especially of importance for the extrapolation of experimental results obtained at high doses and dose-rate to the low-dose rates and low doses of interest in radiation protection. It is finally pointed out that measurements of energy deposition patterns for different radiations may provide the basis for selecting the types of radiation that should be compared in order to obtain information about differences in dose-effect relations for those biological end-points, e.g., tumor induction and genetic effects, that can only be investigated in experiments with large numbers of animals and long observation periods. (auth)

38319 MICROSCOPIC DISTRIBUTION OF RADIATION ENERGY. Rossi, H. H. (Columbia Univ., New York). Contract AT(30-1)-2740. pp 27-55 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

The basic concepts relating to local energy density in irradiated matter and techniques developed for the measurement of the applicable quantities are reviewed with particular emphasis on recent developments at the Radiological Research Laboratory of Columbia University. A critical analysis of the utility of the concepts in the elucidation of radiobiological mechanisms with particular emphasis on geometric considerations such as size and shape of sensitive structures is included. (auth)

38320 QUESTIONS INVOLVED IN DEFINING DOSE LIMITS FOR OCCUPATIONAL EXPOSURE OF THE THYROID AND OTHER ORGANS. Pochin, E. Eric (University Coll. Hospital Medical School, London). pp 1352-5 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The difficulties involved in setting quantitative limits for the occupational exposure of man to radiation, and particularly in setting such limits for different organs or tissues under conditions in which they may be irradiated singly, are discussed. It is pointed out that the long latency of some tumors following radiation exposure prevents an early evaluation of the carcinogenic effects of radiation. Sources of indirect evidence of radiation injury are scanty, particularly for the somatic effects of radiation on different body tissues. The only relevant sources of quantitative human data available apply to carcinogenesis or leukemogenesis at high radiation doses and dose rates, fragmentary data on the effects of radiation on human skin, and numerical estimates of the incidence of thyroid carcinoma following exposure of children to radiation doses of several hundred rads delivered at a high dose rate. Extrapolation of data on high radiation dose rate to low dose rate doses did not provide valid data. It was concluded that the quantitative setting of radiation dose limits for the occupational exposure of man must still be based on inference from indirect evidence. (C.H.)

38321 RADIATION DOSES TO THE GONADS OF PATIENTS FROM DIAGNOSTIC RADIOLOGY IN YUGOSLAVIA. Mihailovic, Mirjana; Pavlic, M.; Mihailovic, M. V.; Klanjscek, G. (Univ. of Ljubljana, Yugoslavia). pp 1547-61 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

An investigation was made of the gonad radiation dose from diagnostic radiography, the genetic dose, and its distribution according to age and sex, in the inhabitants of Slovenia (population, 1.5 million), which is the Alpine part of Yugoslavia (population, 20 million). All subjects were covered by the Yugoslav National Health Service which made it easier to get reliable information on the number and distribution of examinations, as well as on the various techniques. Information on the diagnostic examinations covering the years 1960 and 1963 was collected; over 2,000 measurements of gonad doses were made under actual working conditions in several different institutions, and the significant genetic dose was determined. An average gonad dose of 11.3 mR/year per inhabitant, corresponding to a significant dose of 9.1 mR/year, was obtained. All data collected were analyzed to determine the genetic dose. The total genetic dose per year was calculated to average about 9.1 mR for each inhabitant. (C.H.)

38322 POPULATION DOSE FROM MEDICAL EXPOSURES IN JAPAN (BONE-MARROW DOSE AND GENETICALLY SIGNIFICANT DOSE). Miyakawa, T. pp 1574-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Calculations were made of the radiation dose received by the bone marrow in patients in Japan during radiation therapy using various techniques of irradiation for ^{60}Co γ and x radiation and the internal administration of radioisotopes. It is pointed out that the radiation dose to bone marrow is considered to be closely related to the radiation dose inducing leukemia. (C.H.)

38323 THE GENETICALLY SIGNIFICANT DOSE FROM DIAGNOSTIC RADIOLOGY IN NEW YORK CITY PHYSICIANS' OFFICES. A PRELIMINARY REPORT. Heller, Mortimer B.; Pasternack, Bernard S. (New York Univ.). pp 1567-73 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The genetically significant radiation dose received by patients during diagnostic radiographic procedures carried out in the offices of physicians in New York City during 1961 to 1963 was calculated. Data on 7,947,432 individuals were analyzed by age group, sex, type of examination, and number of examinations. The average gonadal doses calculated were generally higher than those found in other studies. It was concluded that the high gonadal doses were caused by excessive field size. (C.H.)

38324 INTEGRAL DOSE IN X-RAY DIAGNOSIS. Unnerus, C. E.; Kiviniitty, K. (Univ. of Helsinki). pp 1562-6 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Measurement and calculation of the integral radiation dose in diagnostic radiography are important for the control of the methods used; from this one can learn how to reduce radiation doses. However, it is also clear that the doses reported in earlier radiodiagnostic studies must be viewed in general as too large. Thus the cases of genetic and somatic injury should also be checked. It may perhaps be concluded that the hazard of radiation has been somewhat exaggerated. However, even more accurate methods of measuring the absorbed dose may yet be found. For instance, spectrographic measurements may shed additional light on the qualitative differences between incoming and outgoing radiation; mere blackening of a film is no accurate basis for evaluation. (auth)

38325 SOLID-STATE DOSIMETRY IN THERAPY WITH CONVENTIONAL AND ULTRAHARD RADIATION. Wachsmann, F. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg, Ger.). pp 1802-8 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).
From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The possibility of using currently available solid-state dosimeters in radiotherapeutic practice is discussed. Results of personal experiences with photoluminescent glass and thermoluminescent dosimeters are described. A brief report is given on comparative measurements of γ dose distribution in phantoms using solid-state dosimeters and ionization chambers. It is concluded that, although some solid-state dosimeters are already available for laboratory use, they are not yet suitable for radiotherapeutic use. (auth)

38326 EXPERIMENTAL METHODS OF DOSIMETRY IN BONE WITH SPECIAL REFERENCE TO DOSE IN TRABECULAR BONE. Spiers, F. W.; Zanelli, G. D. (General Infirmary, Leeds, Eng.). pp 1809-14 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The availability of activated lithium fluoride powder for use as a thermoluminescent radiation dosimeter offers the possibility of measuring radiation dose under conditions of irregular geometry and small cavity size such as those found in trabecular bone. Trabecular bone specimens were prepared by washing out the marrow with a fine jet of hot water and the dry specimens were filled with LiF powder to provide a representation of the original marrow. Irradiation with x rays of various energies was then carried out under realistic conditions and the LiF powder was recovered for radiation dose measurements. Results of these preliminary studies indicated that LiF powder could be used for measurements of absorbed radiation dose in situations that are inaccessible to other methods of dosimetry. (C.H.)

38327 THERMOLUMINESCENCE OF LITHIUM BORATE AND ITS USE IN DOSIMETRY. Schulman, J. H.; Kirk, R. D.; West, E. J. (Naval Research Lab., Washington, D. C.). pp 1797-1801 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Thermoluminescent dosimeters were developed that use lithium borate ($Li_2B_4O_7$) activated by 0.1 weight percent mn and sealed in small glass tubes. The thermoluminescence response of $Li_2B_4O_7$: Mn was compared with that of LiF as a function of dose of ^{60}Co γ radiation. The range of sensitivity of lithium borate makes it attractive for use in clinical therapy dosimetry. (C.H.)

38328 PROTECTION DOSIMETRY NEAR PARTICLE ACCELERATORS OPERATING AT ENERGIES OF 100 MeV AND BEYOND. Rossi, H. H. (Columbia Univ., New York). pp 1817-22 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Problems encountered in the dosimetry of high energy radiation near particle accelerators operating at energies of 100 MeV and beyond are discussed. It is pointed out that accelerators and their associated materials are sources of an assortment of radiations, since the energy of the primary particles may directly or indirectly release or create any particle known to modern physics. The interactions from which these particles originate take place in the target, the shielding, the air, or the tissues of personnel exposed to stray radiations. The latter results in a particle field within the bodies of the exposed personnel. The particle field should be distinguished from the field of absorbed radiation dose, which is dependent upon the LET and quality factor of the ionizing particles. The combination of a tissue equivalent ionization chamber and a proportional counter operated inside a spherical chamber filled with tissue equivalent liquid was used for measurements of the total absorbed radiation dose and of the distribution of the dose in LET environs of a high energy accelerator. The advantages and disadvantages of the system are discussed. (C.H.)

38329 RADIOCONTAMINATION DURING PREGNANCY. EXPERIMENTAL AND FIELD DATA ON PLACENTAL TRANSFER AND RETENTION OF ^{137}Cs. Sternberg, Joseph (Univ. of Montreal). pp 1537-44 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Factors controlling the uptake of radioisotopes by fetal organisms are reviewed. It was shown that the circulating radioactive compound must cross the placenta in order to reach the fetus and that the rate of placental transfer varies with the physical and chemical structure of the molecule containing the radioactive element. Data are presented from studies on placental transfer and retention of ^{137}Cs and fetal uptake of ^{137}Cs at various times following intravenous injection into pregnant guinea pigs and rats. Data on the content of ^{137}Cs in human placentas collected in Montreal, Canada, during 1964 are compared with similar data from Alaska, Japan, Finland, and Sweden collected from 1961 to 1963. The potential hazards to the fetus of radiocontamination of the mother during pregnancy are discussed briefly. (C.H.)

38330 PROGRESS IN RADIATION THERMOLUMINESCENT DOSIMETRY. Cameron, J. R. (Univ. of Wisconsin, Madison). pp 1784-90 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The characteristics of LiF thermoluminescent radiation dosimeters are described. Thermoluminescent dosimetry in vitro and in vivo is discussed. (C.H.)

38331 ADVANCEMENTS IN CHEMICAL DOSIMETRY. Minder, W. (Sektion fuer Strahlenschutz des Eidgenoessischen Gesundheitsamtes, Bern). pp 1791-6 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Knowledge in chemical dosimetry in the past few years has advanced in three well-established directions. In the growing field of the application of radiation technology, comparatively high doses (of the order of Megarads) are required. Only chemical techniques can be used to measure such doses with a sufficient degree of accuracy. Reactions such as the reduction of ceric sulfate and the destruction of oxalic acid in aqueous solutions, gas reactions, and even reactions in solid salts, have been widely used for different purposes. With radiation chemical reactions, it is also possible to measure total radiation doses in mixed radiation fields, such as, for example, neutrons and gammas, and to differentiate between the components. These possibilities are of very great general interest because the measurement of doses in mixed radiation fields is a difficult task. A small portable chemical dosimeter of sufficient sensitivity would be ideal for personal dosimetry. Very promising progress has also been made in this field, using the production of halogenic acids from halogenated hydrocarbons or the destruction of very large molecules in aqueous solutions by radiations. Devices containing a radiation chemical cell are already widely used in dosimetry systems for radiation accidents. (auth)

38332 PROGRESS IN CALORIMETRIC DOSIMETRY. Laughlin, John S. (Sloan-Kettering Inst., New York). pp 1772-83 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The calorimetric method was developed to provide absolute measurements important to the dosimetry of radiation beams. Energy fluence calorimeters were designed and applied to the measurement of the energy in radiation beams and the calibration of secondary instruments used for output measurement. Homogeneous absorbed dose calorimeters were designed for determination of absorbed dose at any desired point in a medium in situations of biological and clinical importance. These and other more specialized calorimeters were employed in the calibration of secondary dosimeters and of the yield of radiation-chemical reactions. Several different investigators in different nations have successfully constructed and applied calorimeters in dosimetry. The absolute nature of the calorimetric method, together with the precision and reproducibility achieved in different laboratories, should serve to establish it as a preferred primary standard in radiation dosimetry. (auth)

38333 MEASUREMENT OF RADIATION DOSAGE WITHIN THE LIVING SUBJECT: THE NEED AND THE MEANS. Roswit, B.; Malsky, S. J.; Reid, C. B.; Amato, C. G.; Maddalone, L. (Veterans Administration Hospital, New York). pp 1763-71 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

No single radiation detector-reader system will satisfy every need in clinical practice and in investigative radiation medicine. Intensive research is going forward to find the most competent instruments to record dosage distribution with accuracy and with ease in the living organism. A gold-shielded radiophotoluminescent (RPL) glass rod, that could be introduced into body cavities, tissues, and spaces by a polyvinyl catheter satisfied the need for a competent and a practical instrument for clinical and experimental radiation therapy. It is suggested that the glass encapsulated RTL powder (LiF and CaF_2: Mn) will provide still another valuable tool for use in diagnostic, as well as in therapeutic radiology, and nuclear medicine. (C.H.)

Medicine

Refer also to abstracts 37969, 37973, 37997, 38055, 38056, 38174, 38196, 38197, 38231–38233, 38243, 38244, 38272, 38274, 38276, 38282, 38286, 38299, 38300, 38441, 38455, 38472, 38482, 38489, 38490, 38493, 38497, and 38507.

38334 (COO–1653-45) BIOLOGIC CONSIDERATIONS IN ANATOMIC IMAGING WITH RADIONUCLIDES (SELECTIVE ISOTOPIC LABELING OF THE PARATHYROID GLAND). Technical Progress Report. Potchen, E. James (Washington Univ., St. Louis, Mo.). Sept. 1968. Contract AT(11-1)-1653. 11p. Dep. CFSTI.

Multidisciplined investigations designed to improve the clinical utility of radionuclide organ labeling were directed toward a more comprehensive understanding of some biologic factors that influence organ specificity and the pharmacologic means to control this. In addition, kinetic phenomena of anatomic imaging that may provide more functional information than the static scintiscan approach were investigated. Experiments with rats were undertaken to study the effect of EDTA on selenomethionine uptake by the parathyroid glands. No enhancing effect was found. Kinetics of parathyroid selenomethionine turnover were also investigated. Affinity of the parathyroids for ^{125}I-labeled toluidine blue was compared with that for selenomethionine. Effects of a raw soybean diet on uptake of selenomethionine by the rat pancreas were investigated. Studies were conducted on the chemistry of ^{113}In compounds in relation to their organ distribution. A system was developed for preparation of In compounds for blood pool, liver, spleen, and lung scanning. Indium citrate was used for bone scanning. Factors influencing organ distribution of short-lived particles, aggregates, and colloids were studied. A double isotope technique using ^{51}Cr-labeled erythrocytes and ^{131}I-labeled albumin was employed to quantify the extravascular albumin return rate for assessment of regional lymph transport. Kinetics of xenon washout following intra-arterial injection of ^{133}Xe was studied using the Nuclear Image Intensifier camera. Studies were conducted on lung scintiscanning and control mechanisms of regional pulmonary perfusion. Mechanisms controlling Tc extravascular distribution and intravascular return rate following intravenous injection were studied using ^{99}Tc. Cerebral blood flow studies were conducted using ^{133}Xe. (H.L.W.)

38335 (DASA–2064) RELATION BETWEEN EARDRUM FAILURE AND BLAST-INDUCED PRESSURE VARIATIONS. White, Clayton S.; Bowen, I. G.; Richmond, Donald R. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1967. Contract DA-49-146-XZ-372. 60p. Dep. CFSTI.

In field and laboratory experiments designed to study overall blast effects, incidental observations were made of the ears of over 490 animals. Those inside structures were exposed to a variety of atypical blast waves. Those located inside shock tubes or in the open when high explosives were detonated were exposed to fairly typical wave forms. An attempt was made to relate the incidence of eardrum rupture to various elements of the measured pressure-time curves. The association was not the same for typical and atypical wave forms. Within the limits of the meager data available, the quantitative differences were noted and discussed with emphasis on the apparent wide variability in tolerance for which an explanation was proposed. (auth)

38336 (JPRS–44166) RECOMMENDATIONS FOR THERAPY OF PERSONS EXPOSED TO SUBLETHAL AND LETHAL RADIATION. Translated from Vojnosanit. Pregl., No. 11, 598-600 (Nov. 1967). 9p. CFSTI.

Administration of homologous bone marrow as a therapeutic procedure for irradiated persons is discussed. The possible lethal consequence of immune reactions to injected bone marrow is emphasized. Recommendations are presented for the selection of irradiated persons for bone marrow injections. It is pointed out that bone marrow injections should be given only to individuals who have received lethal doses. A waiting period of six days postirradiation prior to injection allows inhibition of immunological activity in lethally irradiated persons, permits careful evaluation of dose and diagnosis of injury, and provides time for adequate evaluation of the need for bone marrow injections. (C.H.)

38337 THE SUITABILITY OF LOW-ENERGY GAMMA-EMITTERS FOR SCINTIGRAPHY. PHANTOM STUDIES WITH ^{125}I, ^{197}Hg, ^{99m}Tc, AND ^{131}I. Moll, E.; Sinagowitz, E.; Boerner, W.; Rauh, E. (Medizinische Univ., Wuerzburg, Ger.). Nucl.-Med. 7: 8-27(May 15, 1968). (In German).

For the purpose of testing the suitability of the radioisotopes ^{125}I, ^{197}Hg, ^{99m}Tc, and ^{131}I for scintigraphy a series of scintigrams were done using a phantom and a commercially available color scanner and varying the water level above the phantom and the electronic settings of the instrument. A point system was used for the semiquantitative comparison of the scintigrams. The low-energy γ-emitters ^{197}Hg and in particular ^{99m}Tc yielded scintigrams with good resolution even in greater depths. Under all test conditions ^{99m}Tc was equal or superior to ^{131}I. On the other hand, the ^{125}I scintigrams were considerably poorer than those of the three other radioisotopes below a water depth of 20 mm. Because of the favorable physical properties of the low-energy γ-emitters ^{99m}Tc and ^{197}Hg, larger amounts of activity could be administered with a considerable reduction in radiation dose. Therefore higher counting rates were available and the information content of the scintigrams was increased. (35 references.) (auth)

38338 ORIGIN AND INTERPRETATION OF THE RADIORENOGRAM. Motzkus, F.; Bachmann, D. (Freie Univ., Berlin). Nucl.-Med. 7: 47-58(May 15, 1968). (In German).

A mathematical analysis of the intravenous radiorenogram was done using parameters that were obtained by selective radiorenography with ^{131}I-Hippuran or ^{131}I-inulin. In analogy to certain pathophysiological conditions the parameters were altered, the curves obtained analyzed, and then compared with each other. The results indicated that the characteristic alterations of the renal activity curves occurring in the intravenous radiorenogram may be caused by different renal and extrarenal factors. A detailed diagnosis from the intravenous radiorenogram for the individual kidney could be established only if very marked disorders of renal function and evacuation were present. Intravenous radiorenography with compounds that are filtered glomerularly appeared to be unsuitable for clinical use. (auth)

38339 RADIOISOTOPE SCANNING AS AN AID IN THE DIAGNOSIS OF SPLENIC CYSTS. Razzak, Muhammad A.; Sodee, D. Bruce (Renner Clinic Foundation and Doctors Hospital, Cleveland). Nucl.-Med. 7: 59-64(May 15, 1968).

The presence of a splenic cyst that is suspected on clinical grounds, can be more efficiently diagnosed using routine radiological techniques. With the application of more refined procedures, such as radioisotope scanning using ^{51}Cr-erythrocytes, and arteriography, the diagnosis can be confirmed even before surgical exploration. An illustrative case is presented. (auth)

38340 THE TSH TEST IN PERSONS HAVING RECEIVED IODINE COMPOUNDS. Papadopoulos, S. N.; Livadas, D.; Sfontouris, J.; MacFarlane, S.; Koutras, D. A. (Athens Univ. Alexandra Hospital, Athens). Nucl.-Med. 7: 65-72(May 15, 1968).

The two-hr ^{132}I thyroid uptake was measured serially in five groups of normal volunteers whereas the two-hr and the 24-hr uptake of ^{131}I were measured in a sixth group. Following administration of potassium iodide in doses of 40, 200, and 1000 mg, Urografin, or Biligrafin intravenously, the thyroid uptake decreased to very low values. A single injection thereafter of 10 I.U. of TSH increased these low values to levels within the normal range. A direct assessment of the individual level of thyroid function could not be obtained by the described procedure because of lack of linear correlation between the values obtained for the plasma inorganic iodine and the uptake measurements after TSH administration. It was concluded that TSH could be used for differentiating low uptake values due to primary hypothyroidism from those after iodine ingestion in either inorganic form. In such patients, TSH may also help in obtaining a better scintigram of the thyroid gland. (auth)

38341 A SIMPLE METHOD FOR LOCALIZATION IN GAMMA-CAMERA SCINTIGRAPHY. Patomaeki, L. K.; Anttila, P. A. (University Central Hospital, Helsinki). Nucl.-Med. 7: 91-6 (May 15, 1968).

A new and simple localization method for use in scintigraphy using γ cameras is described that can be applied immediately without alteration in the instrumentation of any scintillation camera. The equipment consists of a sheet of cork, some millimeters in thickness, on which polar coordinates have been drawn and which are fixed on the detector face of the camera. Immediately after the scintiphoto is taken (and with the patient still in position), a drawing-pin is inserted into the cork at points corresponding to the localization of certain palpable anatomical features, or to two pieces of metal placed over such features. After the patient has left, the coordinates are read and the position of the points transferred to the scintiphoto by means of coordinates having the same scale as the polaroid picture. A radiograph may be taken (at least when the pieces of metal are used) of the scintigraphed area of the patient in the same position in which the scintiphoto was taken. The small metal pieces will be seen on the radiograph so that their positions are now known in the scintiphoto. (auth) (TSS)

38342 A RAPID RADIOISOTOPE DILUTION TECHNIQUE FOR THE ACCURATE DETERMINATION OF THE CARDIAC OUTPUT. Razzak, Muhammad A.; Botti, Robert E.; MacIntyre, William J. (Case Western Reserve Univ., Cleveland). Nucl.-Med., 7: 1-7 (May 15, 1968).

A pair of printing scalers was used to record the information obtained by external monitoring of the isotope dilution curve following the intravenous injection of ^{131}I-labeled human serum albumin. The first scaler gave the differential count rate of the curve at increments of one second, whereas the second continuously integrated the isotope dilution curve. This recording de-

vice enabled cardiac output determinations to be calculated rapidly at the bedside without any loss in accuracy. Using this method in 15 normal individuals, the cardiac output was found to be 6.13 ± 0.73 liters/minute (Mean ± 1 S.D.), with a cardiac index of 3.36 ± 0.35 liters/minute/m^2. In the same group of normals, the stroke index (stroke volume/surface area) amounted to 50 ± 7.3 ml/beat/m^2. Comparison of the results of this method with those obtained by integration of the entire isotope dilution curve by an IBM 1620 computer showed excellent agreement and thereby proved the validity of the suggested technique. (auth)

38343 ^{87m}Sr SCANNING OF PELVIC BONES. Jasinski, Wladyslaw K.; Malinowska, Janina; Mackiewicz, Henryk; Siwicki, Henryk; Lukawska, Krystyna (Inst. of Oncology, Warsaw). Nucl.-Med. 7: 28-36(May 15, 1968).

The accumulation of ^{87m}Sr in the proximal parts of the femoral bones of patients treated previously by external irradiation for cancer of the uterine cervix was investigated. It was assumed that this method may be used in the future for the early diagnosis of postirradiation changes of bone (osteoradionecrosis). The incidence of postirradiation changes of the femoral neck among 5735 patients was 0.8%. In the early period of postirradiation changes the patients complained only of pain and limitation of physical activities. If radiological and gynocological findings were negative, the differential diagnosis between early recurrence and early osteoradionecrosis became impossible. Forty-nine selected patients were scanned after intravenous injection of 10 to 115 μCi of ^{87m}Sr per kg of body weight (0.5 up to 6.0 mCi). Illustrative cases of normal pelvic bones as well as postirradiation changes are presented and discussed. It was concluded that the findings justify further systematic studies on the morphology of accumulation of ^{87m}Sr in the bones. (auth)

38344 PROFILE-COUNTING STUDY OF PATHOLOGICAL LESIONS OF THE SKELETON WITH ^{85}Sr. Skupenova, A.; Hupka, S.; Kovac, V.; Jancina, J.; Simko, S. (Komensky Univ., Bratislava). Nucl.-Med. 7: 38-45(May 15, 1968). (In German).

The present status of radioisotope diagnosis of skeletal lesions is discussed with reference to the use of various bone-seeking radioisotopes. A profile-counting method adapted to studies of ^{85}Sr distribution in the skeleton is described and some results obtained with this method are reported. The possibilities of interpretation of the counting profiles are discussed. The advantages of this method, its relation to radiological diagnosis, and their clinical significance are outlined. (auth)

38345 RADIOIODINE IN THE DIAGNOSIS AND THERAPY OF SOLITARY HYPERFUNCTIONING THYROID NODULES. Al Hindawi, A. Y.; Al-Hiti, Th. N.; Baba, W. I. (Univ. of Bagdad). Nucl.-Med. 7: 82-90(May 15, 1968).

The clinical presentation, the incidence, and the results of ^{131}I tests in 80 patients with hyperfunctioning thyroid nodule confirmed by scanning are presented. Fifty-two patients had toxic adenoma and 28 were euthyroid. The value of different radioiodine tests of thyroid function in confirming the diagnosis is discussed. The topographical changes in both hyperfunctioning nodule and suppressed tissue of the thyroid gland following exogenous TSH and ^{131}I therapy showed refunctioning of suppressed thyroid tissue. Relatively high doses of radioiodine were required to treat toxic adenoma of the thyroid gland. (auth)

38346 APPARATUS FOR MEASUREMENTS OF ^{131}I UPTAKE IN THE THYROID GLAND ACCORDING TO IAEA RECOMMENDATIONS. Husak, V.; Erban, J.; Kleinbauer, K.; Synek, V. (Palacky-Univ., Olomouc, Czech). Radiobiol.-Radiother., 8: 579-85 (1967). (In German).

The explanations about ^{131}I uptake measurements in the thyroid gland within the IAEA (International Atomic Energy Agency) recommendations are summarized. With respect to the fact that at present there is no appropriate apparatus available, a collimator was built and fastened to a stand; it will be used in connection with a pulse counter and NK-108 analyzer. The measurements with ^{131}I and ^{99}Tc point sources revealed that this collimator met the demands with regard to the size of visual field as well as the shielding of the scintillation crystal. The complete apparatus with the phantom, as well as the method of measurement, met the IAEA recommendations. (auth)

38347 RESULTS OF RADIOIODINE THERAPY (^{131}I) FOR HYPERTHYREOSES. Langbein, W. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 557-69(1967). (In German).

Results of treatment of 177 cases of hyperthyroidism with ^{131}I are reported. Eighty-six per cent of the patients were cured and in three-fifths of these cases only one dose of ^{131}I was required. Temporary hypothyroidism occurred in 4.5% and permanent hypothyroidism occurred in 8.0% of the patients. Ten patients were not helped. The selection of cases for ^{131}I therapy is discussed with respect to age, sex, and operative risk. It is pointed out that the hazards of genetic and somatic radiation injuries in adolescents and adults under 45 years of age should be considered. (C.H.)

38348 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BEAMS OF PHOTONS AND OF 20 MeV ELECTRONS. Wambersie, A. J. Belge Radiol., Monogr. 1, 1-13(1967). (In French).

The term relative biological efficiency (RBE) is defined. The physical and radiobiological aspects of the study of the RBE of ^{60}Co γ and betatron-produced high-energy electrons used for therapy are described. (J.S.R.)

38349 BETA-APPLICATORS ON THE BASIS OF ION-EXCHANGE TISSUES. Braitsev, A. V.; Virnik, A. D.; Salnikov, E. T.; Rogovin, Z. A. (Central Scientific-Research Inst. of Dermatology and Venereal Diseases, Moscow. Moscow Textile Inst.). Med. Radiol., 12: No. 8, 25-8(Apr. 1967). (In Russian).

An original method of preparing beta-applicators on the basis of ion-exchange tissues from inoculated cellulose copolymers with polyacrylic acid and poly-2-methyl-5-vinyl-pyridine, endowed with anion-cation exchange properties, is described. In contrast to applicators, prepared by other methods, these beta-applicators are endowed with uniform radiation of the entire area and are devoid of the regional zone of isotope accumulation. These properties were confirmed radioautographically and experimentally on animals. The clinical trial of the applicators proposed, in the treatment of 122 patients, showed their high efficacy in eczema, neurodermatitis, and hemangioma. The low cost is also an advantage. (auth)

38350 INCREASED EMBRYONIC SURVIVAL IN IRRADIATED RATS RECEIVING PROGESTERONE THERAPY. Ward, William F.; Hahn, Eric W. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Radiat. Res., 33: 574-87(1968). (UR-49-817).

Average numbers of living fetuses in female rats exposed to 300 R of whole-body x irradiation on the morning prior to mating were significantly ($p \leq 0.05$) increased following administration of 1.0 mg of progesterone (sc) on the afternoon prior to mating, by 7.5 mg of progesterone (sc) on days seven to 12 of pregnancy, or by a combination of the above therapies. Radioinduced maternal dysfunction was a contributing factor in a portion of the embryonic mortality observed in rats irradiated shortly before mating. (auth)

38351 PERCEPTION AND PROCESSING OF MEDICAL RADIOISOTOPE SCANS. Pizer, Stephen M. (Massachusetts General Hospital, Boston); Vetter, Henri G. pp 147-56 of Pictorial Pattern Recognition. Cheng, George C.; Ledley, Robert S.; Pollock, Donald K.; Rosenfeld, Azriel (eds.). Washington, D. C., Thompson Book Co., 1968.

From Symposium on Automatic Photointerpretation, Washington, D. C. See CONF-670541.

A study to determine optimum processing procedures for radioisotope scans for human observation and interpretation is described. The process is divided into two successive degradations, geometrical and statistical. Various smoothing methods are discussed, including fixed averaging, variable averaging, and dot shifting. (W.H.K.)

38352 EFFECT OF DIFFERENT DOSE RATES IN IRRADIATION OF MICE UNDER HYPOXIC CONDITIONS. Smirnov, O. P. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 779-85 (1967). (In German).

Investigations of the oxygen effect offer a possibility of studying single steps of the mechanism of the biological radiation effect. The influence of dose rate on the biological effect in mice who were γ-irradiated with different oxygen contents of the environment was examined. The following dose rates were tested: 3, 6, 280, and 3060 R/min. A protective effect of hypoxy (7 percent of oxygen) was only found for intensities of 280 and 3060 R/min. For these high dose rates a dependence of the hypoxic effect on the radiation dose was found. The causes of the different participation of oxygen in radiation injury depending on dose and dose rate are discussed. (auth)

38353 THE EFFECT OF SOURCE SIZE ON THE ISODOSE-DISTRIBUTION AT "GRAVICERT" (MEDICOR, HUNGARY) ^{60}Co TELETHERAPY UNIT. Dezsi, Z.; Miltenyi, L. (Medical Univ., Debrecen, Hungary). Radiobiol.-Radiother., 8: 761-2(1967).

It was found that at the Gravicert teletherapy unit the smaller source size is more advantageous than a large one, even with an identical diaphragm system. The measurements were made using the decrement-lines method. (auth)

38354 COMPARATIVE ACTIVITY OF VARIOUS THIOL COMPOUNDS AS RADIOPROTECTORS. Gusareva, E. V. Radiobiologiya, 7: 446-51(1967). (In Russian).

The protective effect of cysteamine (I), butyl mercaptan (II),

ethyl mercaptan (III), Na thioglycolate (IV), mercaptoethanol (V), and unithiol (VI) in various doses on cells of a hyperploid strain of Ehrlich's ascites carcinoma irradiated with 700 R of x-rays was studied. The thiol compounds had toxic effects on the cells to various degrees, but did not alter the relative content of cells with chromosome aberrations. The protective effect of the compounds, which was determined on the basis of the reduction of the ratio of cells with chromosome aberrations (there were no significant differences in mitotic activity) depended mainly on the thiol group concentration in the solution; it was not related to the chemical constitution of the compounds. This can be explained by assuming that endogenous thiol groups formed in the cells under the action of the thiol compounds exerted the protective effect. The protective effect of I, IV, II, V, and VI injected subcutaneously in doses of 0.5 and 3.0, 0.5 to 5.0, 15.0, 1.0 to 5.0, and 14 mg, respectively, to mice irradiated with 900 R of γ-rays was determined on the basis of the rate and time of survival. A protective effect was obtained only with I (3.0 mg) and VI (14.0 mg). (JPRS)

38355 ROLE OF SLEEP IN THE MECHANISM OF THE RADIOPROTECTIVE EFFECT OF HYPNOTICS. Strelkov, R. B.; Parasochko, L. A. Radiobiologiya, 7: 459-61(1967). (In Russian).

The protective effect of barbamyl injected subcutaneously to mice in amounts of 75 to 150 mg/kg against 700 and 900 R of γ radiation was studied in two series of experiments: in one, the animals were allowed to fall asleep under the action of the hypnotic, while in the other the hypnotic was combined with caffeine so that sleep was prevented and the animals were placed in the same cage as control mice during irradiation. Barbamyl did not exert any protective effect on irradiation with 900 R. On irradiation with 700 R, of the mice injected with 100 mg/kg of barbamyl, the ratio of animals that survived was 35.7% under the effect of barbamyl + sleep vs 44.1% for barbamyl without sleep and 18.8% for control animals. On injection of barbamyl in a dose of 75 mg/kg, which practically did not produce sleep, and irradiation with 700 R, the survival ratio was 27.2%. The results indicated that sleep as such does not play a significant role in the protective action of barbamyl against radiation. One may assume that the anticholinesterase activity of barbamyl is of importance in the protection mechanism: acetylcholine, which is known to exert a protective effect against radiation, accumulates in the organism under the action of barbamyl. (JPRS)

38356 FORENSIC MEDICINE AND RADIOISOTOPES. Pribilla, O. (Univ., Kiel). Atompraxis, 14: 187-93(Apr.-May 1968). (In German).

Accidents to personnel working with radioactive materials and fallout contamination of man over a period of years are reported. Strontium-90 contamination of human diet, bones, and placenta are reported. The ^{90}Sr dose to bones was determined. Results of studies on ^{137}Cs contamination of tissues are presented. A case of death from diagnostic use of ^{131}I is discussed. Problems associated with contaminated bodies and isotopic methods in forensic medicine and forensic toxicology are discussed. (H.L.W.)

38357 SPLENIC RUPTURE: APPLICATION OF RADIOISOTOPIC TECHNIQUES IN DIAGNOSIS. Jackson, George L.; Albright, Derek. J. Amer. Med. Ass., 204: 178-9(June 3, 1968).

The diagnosis of splenic rupture with subcapsular hematoma is difficult, and there are few reliable diagnostic aids. This report documents the value of the spleen scan using ^{51}Cr-labeled erythrocytes in a patient whose injury was sustained six days previously. (auth)

38358 EFFECT OF DIMETHYL SULFOXIDE ON PLASMA EN ZYME CHANGES IN X-IRRADIATED RATS. Highman, Benjamin; Hansell, John R.; White, David C. (National Insts. of Health, Bethesda, Md. National Center for Radiological Health, Rockville, Md. Armed Forces Inst. of Pathology, Washington, D. C.). Proc. Soc. Exp. Biol. Med., 125: 606-10(June 1967).

Rats were given intraperitoneally 10 ml/kg 0.85% saline or 5.5 g/kg 50% dimethyl sulfoxide (DMSO), a radioprotective compound, before exposure to 800 R whole-body x irradiation. Values of plasma glutamic oxalacetic (GOT) and pyruvic (GPT) transaminases, aldolase, alkaline phosphatase, and lactic and malic dehydrogenases were determined. In nonirradiated controls, DMSO elevated plasma GOT and GPT values at 6 hours and aldolase at 6 to 48 hours. Values were normal 3 to 12 days after DMSO. In irradiated rats given saline or DMSO, plasma GOT was higher than in nonirradiated controls at 6 hours and then fell, along with the other enzymes, to subnormal values at 3 to 12 days. Levels of GOT, GPT, and aldolase were higher 6 to 24 hours after irradiation in rats given DMSO than in those given saline. A second dose of DMSO caused a proportionally similar elevation when given 2 days after irradiation, but had relatively little effect on enzyme levels when given 5 days after irradiation. Pretreatment with DMSO did not prevent the fall in enzyme values noted 3 to 12 days after x irradiation and had no marked effect on histologic changes. It was concluded that x irradiation caused an initial widespread increase in cellular permeability followed by a decrease, and that plasma enzyme changes do not explain the radioprotective action of DMSO and are unreliable guides in evaluating the possible radioprotective effect of different compounds. (auth)

38359 RAPID SCINTIPHOTOGRAPHIC PLACENTAL LOCALIZATIONS UTILIZING FREE ^{99m}Tc PERTECHNETATE. Lavine, Daniel M.; Fish, Mathews B.; Pollycove, Myron; Khentigan, Archie (San Francisco General Hospital, Calif. Univ. of California, San Francisco). J. Nucl. Med., 8: 773-84(Nov. 1967).

The use of free ^{99m}Tc-pertechnetate ion for placental localization was evaluated in 18 patients in the third trimester of pregnancy. Unequivocal localization and imaging of the placenta were performed with 300 μCi ^{99m}Tc within five minutes after injection of the pertechnetate bolus. This rapid and precise localization of the placenta was accomplished through use of the Anger-type scintillation camera to image the initial vascular distribution of the pertechnetate bolus in the placenta. Fetal radiation was very low, i.e., 5 mR or less. (auth)

38360 RELATIONSHIP OF SURFACE AREA ON ROENTGENOGRAMS AND RADIOISOTOPIC SCANS TO ORGAN VOLUMES. Spencer, Richard P. (Yale Univ., New Haven). J. Nucl. Med., 8: 785-91(Nov. 1967).

The relationship of the apparent organ cross-sectional area, on roentgenograms and on radioisotopic scans, to the volume of the organ, was analyzed in terms of the dimensions involved. logarithmic plot of the organ's volume (or weight, assuming a constant density) as a function of the logarithm of the apparent area was utilized. This was illustrated by literature data for the spleen, thyroid, and kidney. The theory behind such a log-log plot and its limitations, is outlined. (auth)

38361 PENETRATION OF BRAIN AND BRAIN TUMOR. VI. RADIOACTIVE SCANNING AGENTS. Soloway, A. H.; Aronow, S.; Kaufman, C.; Balcius, J. F.; Whitman, B.; Messer, J. R. (Massachusetts General Hospital, Boston). Contract AT(30-1)-3267. J. Nucl. Med., 8: 792-9(Nov. 1967).

Three groups of potentially useful scanning agents (11 compounds) were studied in mice with subcutaneously implanted ependymoblastomas. The results do not appear to be directly related to the scanning efficiency of a compound in man, but may have merit for elucidating substances which are tumor-binding. The radioisotopes selected for evaluation included ^{99}Tc, ^{64}Cu, ^{74}As, ^{197}Hg, ^{32}P, ^{42}K, ^{18}F, ^{51}Cr, ^{72}Ga, and ^{56}Mn. Permanganate labeled with ^{56}Mn showed levels in blood, muscle, and normal brain, which were appreciably lower than in the neoplasm at times of two to four hours after administration; ^{18}F, though desirable from a physical standpoint, did not show any special propensity for neoplastic brain as the fluoride ion. However, in this form bone concentration was extremely high even five minutes after injection. A better biological model for evaluating scanning agents is needed and new ways are considered. (auth) (TSS)

38362 STUDY OF EXTRA-THYROIDAL NECK RADIOACTIVITY USING A RADIOISOTOPE SCANNER. Hilditch, T. E.; Gillespie, F. C.; Shimmins, J.; Harden, R. McG.; Alexander, W. D. (Gardiner Inst., Western Infirmary, Glasgow). J. Nucl. Med., 8: 810-21(Nov. 1967).

The contribution of the extra-thyroidal ^{131}I neck activity to the counts recorded by a scintillation scanner was measured, and the apparent neck activity measured by the scanner compared to that measured by an I.A.E.A. collimated scintillation uptake counter. The results were analyzed, taking into consideration the calculated errors in the method. No significant difference was found between the neck activity as measured by the scanner and as measured by the uptake counter. The contribution from extra-thyroidal activity falls with time after injection. The value at 30 min was 77% of the 3 min value. This decrease was less than the comparable fall in plasma activity. These results provide a basis for measurement of early uptake and clearance of ^{131}I using an I.A.E.A. collimated detector. (auth)

38363 EFFECT OF A METALLIC FOIL ON THE DOSE DISTRIBUTION IN PLEXIGLASS IRRADIATED BY HIGH ENERGY ELECTRONS. Dutreix, J.; Bernard, M. (Institut Gustave Roussy, Villejuif, France). Biophysik, 4: 302-10(1968). (In French).

A heterogeneous foil of atomic number Z much higher than that of water has an effect on the dose depth distribution of high-energy electrons. The dose is augmented at contact and in the immediate neighborhood of the heterogeneous foil but it is decreased at greater distance. In the usual case of radiotherapy, where the foil is constituted by a limited thickness of gold, and in the case

of radiobiological experimentation, where the heterogeneity is constituted by the glass walls, the overdosage is less than 5% for electrons with energy between 10 and 20 MeV. The dose depth distribution is approximately represented by the standard curve and the depths are expressed in surface mass (g/cm^2). An absorption equivalent thickness (AET) equal to the actual thickness multiplied by the density of the heterogeneous foil can then be admitted. However, in rigorous experiments which demand a high precision, the calculation of the dose in depths by the AET is not satisfactory and direct measurement is indispensable. (tr-auth)

38364 CHANGING CONCEPTS IN CHEST FLUOROSCOPY. Gondos, Bela (District of Columbia General Hospital, Washington). Med. Ann. D. C., 36: 385-90; 94(July 1967).

The concept that fluoroscopy is simply another office procedure of the practicing physician is false and hazardous. Satisfactory structural shielding should be provided and modern x-ray equipment should be used. The requirements for up-to-date x-ray facilities were commonly not met, particularly among nonradiologists. Lead gloves and apron should be worn. Adequate dark adaptation was a requirement which was commonly disregarded or incompletely done, resulting in an unsatisfactory examination and prolonged exposure. The field of exposure (the diaphragmatic aperture) should be small. Exposure should be limited to useful observation only. The entire length of fluoroscopic exposure should be limited to a possible minimum by a timing device. The output of radiation at the tabletop should be calibrated and should not exceed 10 R/min. Fluoroscopy of the chest as an independent examination should be abandoned. Whenever employed, it should always be preceded by roentgenography and used only as a complementary procedure. After a study of the roentgenograms (frontal and lateral), generally the thoracic lesion in question was already located and the questions needed for clarification formulated. The subsequent aimed fluoroscopy should then require only a limited time of exposure. (BBB)

38365 RADIOACTIVE PHOSPHORUS IN NORMAL AND PATHOLOGICAL PROSTATE. Voutilainen, A.; Rytilae, A. (Univ. of Oulu, Finland). Ann. Chir. Gynaecol. Fenn., 56: 130-2(1967).

The incorporation of ^{32}P in normal and malignant human prostate tissue was studied in attempts to develop a new method for detection of prostatic cancer. Radiation doses received by the patient were calculated. The series consisted of 42 patients of whom 15 had hypertrophic prostate, 13 carcinoma of the prostate, and 14 a normal-sized prostate. The patients were injected with 100 μCi of ^{32}P-orthophosphate in sterilized isotonic saline containing phosphate buffer. The β radiation emitted by the isotope which found its way to the prostate was measured immediately from the surface of the prostate with a miniature needle G-M counter at half-minute intervals from the moment of injection. Uptake was highest in hypertrophy of the prostate (average maximum uptake of 44 cpm) then in normal prostate (35 cpm) and lowest in prostatic cancer (27 cpm). The uptake was the same in the two first mentioned states 30 sec after the ^{32}P injection, while it was considerably lower in prostatic cancer. Measurements performed during the first minute, when the prostate-localizing activity of the isotope was slight, could be used in the diagnosis of cancer of the prostate. The radiation dose to the patient during the examination was calculated for the body as a whole or per organ. It was assumed that, in a man of 70 Kg given 100 μCi of ^{32}P, it was uniformly distributed throughout the tissues and that the factor representing the rate of absorption and excretion was 0.52. The value 1.44 was obtained by integration of the dose over infinite time, with average life 14.3×1.44. Given these assumptions, the whole-body dose was 0.5 rad. Since a man of 70 Kg had about 7 Kg of bone, the concentration was about 1.5 μCi/Kg of bone and the bone dosage was about 1 rad. (BBB)

38366 STUDY FOR THE REDUCTION OF RADIATION DAMAGE TO THE OSSIFICATION ZONE IN THE DEVELOPING OF NEWBORN RABBITS BY GIVING OF DUROBOLIN, VITAMIN D_2, AND POWDERED EGG SHELLS. Horvath, Franz; Horvath, Josef (Univ., Budapest). Strahlentherapie, 135: 38-47(1968). (In German).

An attempt was made to decrease the bone damaging effect of x irradiation in growing rabbits. Durabolin (19-nor-adrosterone-phenylpropionate) or vitamin D_2 and powdered egg shells were given in addition to the x irradiation. The effect obtained was registered using roentgenological and histological investigations. The following results were obtained: Durabolin as well as powdered egg shells and vitamin D_2 decreased the acute and chronic radiation damage to the epiphysis of growing bone. Deformations of the epiphyses and structural abnormities similar to the ones observed during rachitis were not seen. Durabolin showed a more favorable effect, which was not only seen in roentgenograms and histological sections, but also in the general condition of the animals used. (auth)

38367 PREPARATION OF LABELED CARBOHYDRATES FOR BIOMEDICAL USES. Tubis, Manual; Parsons, Kenneth; Endow, John S.; Rawalay, Surjan S.; Crandall, Paul H. (Veterans Administration Center, Los Angeles. Univ. of California, Los Angeles). J. Nucl. Med., 8: 551-7(Aug. 1967).

Methods are presented for the preparation of propargyl ethers of inulin, dextrans, and mannitol. These can be prepared and radioiodinated on demand. These methods can be advantageously used to label other carbohydrates and polyhydroxy compounds. The radioiodinated materials were prepared of adequate specific activity, sterile and pyrogen-free and of acceptable free radioiodide content. (auth)

38368 INTEGRAL DOSE IN RADIOTHERAPEUTIC PRACTICE. Bhushan, Vidya (Safdarjang Hospital, New Delhi). Indian J. Radiol., 21: 48-53(Feb. 1967).

The integral absorbed dose, determination of the relative integral dose (RID), calculations of RID, dependence of RID on RBE, and the relation between RID and the therapeutic ratio were discussed. The definition of RID as suggested by Scarpa was modified to give a better correlation between the patients' response to radiation treatment and the dose. The values of RID and the whole-body integral absorbed dose were calculated and discussed for nine patients' planned treatments of carcinoma of the esophagus by ^{60}Co teletherapy. It was suggested that the value of RID would be more significant than integral dose in comparing the reactions due to various courses of radiotherapy involving different qualities of radiation because it was less sensitive to changes in quality of the radiation. (BBB)

38369 MORPHOLOGICAL CHANGES IN MILK-DUCT CARCINOMA AFTER INTRAVENOUS ADMINISTRATION OF COLLOIDAL ^{198}Au. Badmaeva, V. V.; Morozov, A. P.; Ashikhmina, I. G. (Moscow Scientific-Research Inst. of Oncology). Med. Radiol., 13: No. 5, 31-7(May 1968). (In Russian).

An insignificant radiation effect was observed following the intravenous administration of ^{198}Au because of its irregular distribution in tumors. The main mass of neoplastic tissue and invasive growth was not affected. In the glandular tissue there were radiation changes in glandular structures and in lymph ducts of the stroma. Comparisons of morphological findings with dosimetry data were used to evaluate the use of ^{198}Au in patients with milk-duct carcinoma. (auth)

38370 TREATMENT OF RADIATION INJURIES OF THE SKIN WITH DIBUNOL. Disvetova, V. V.; Genieva, E. N.; Evseenko, L. S.; Ratkevich, G. I.; Bogoslovskaya, E. P. (First Moscow City Clinical Hospital. Inst. of Chemical Physics, Moscow). Med. Radiol., 13: No. 5, 43-6(May 1968). (In Russian).

A 5% emulsion of dibunol (ionol) was used for the treatment of 25 patients with radiation ulcers and 15 patients with radiation dermatitis. In 14 patients radiation uclers healed, and, in 10 the ulcers decreased in periods of 1 to 1½ months. With such treatment, dermatitis disappeared in 3 to 10 days. The healing was stable with the formation of a tender scar. (auth)

38371 TREATMENT OF INFORMATION FOR DETERMINING THE FUNCTIONING TISSUE OF THE ORGAN IN SCANNING. Serebryanyi, E. G.; Reginskii, A. N.; Khodarev, N. N.; Ishmukhametov, A. I. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 5, 53-7(May 1968). (In Russian).

In order to establish by means of radioisotope scanning the physiological state of human organs it is necessary to determine the size and topography of its functioning tissue. A method of mathematical treatment of the information from liver scans is presented that can be used to assess the limits of this organ. In zones of functioning tissue and background it was necessary to distribute the calculations according to Puassons' law; in the transient region such a regularity was not noted. Fluctuation and other hindrances were eliminated on the basis of solving the discrepancies between spatial spread of the information in each zone, as well as spatial compactness of the functioning tissue and surrounding background. (auth)

38372 ASSESSMENT OF THE RELIABILITY OF THE RESULTS OF RADIOISOTOPE DIAGNOSIS OF TUMORS. Gurtovoi, G. K.; Trukhanov, K. A. Med. Radiol., 13: No. 5, 58-62 (May 1968). (In Russian).

Assessment of the results derived during radioisotope diagnosis of tumors requires statistical recording of the breakdown of radioactive atoms in the instance if the total count does not exceed several thousand impulses. A method is presented for assessing the reliability of the isotope diagnosis. (auth)

38373 RADIOISOTOPE RENOGRAPHY IN LYMPHOGRANULOMATOSIS AND CHRONIC LEUKEMIA. Gorbadei, N. K.; Bartova, V. F.; Lapchenkov, V. I. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: No. 5, 62-5(May 1968). (In Russian).

Data are summarized from investigations of kidney function with the aid of radioisotope renography in 32 patients suffering from Hodgkin's disease and in 6 patients with chronic leukemia. Functional disturbances of the kidneys were manifested by prolongation of the vascular, secretory, and excretory phases; they were particularly marked in patients with enlarged retroperitoneal lymph nodes. (auth)

38374 USE OF ^{131}I LABELLED HIPPURAN FOR ASSESSING THE KIDNEY FUNCTION IN CARDIOVASCULAR DISEASES. Leshchinskii, L. A.; Trusov, V. V. (Izhev Medical Inst., USSR). Med. Radiol., 13: No. 5, 65-70(May 1968). (In Russian).

Radioisotope renography with ^{131}I-labeled hippuran was used for assessing kidney function in 345 patients with cardiovascular diseases (152 with circulatory insufficiency and 193 with hypertensive vascular disease). A number of new indices for deciphering of renograms are presented. The investigations demonstrated that the above method is of great practical value in its clinical use in internal diseases. The use of ^{131}I-hippuran tests in cardiovascular diseases helped to differentiate symptomatic hypertension of renal genesis, to determine the degree of functional disorder, and to carry out dynamic observations in the process of treatment. (auth)

38375 RADIOISOTOPE RENOGRAPHY IN CHILDREN WITH DISEASES OF THE KIDNEYS. Soskin, A. M.; Kazimirov, V. G. (Moscow Regional Scientific Research Clinical Inst.). Med. Radiol., 13: No. 5, 70-6(May 1968). (In Russian).

The extraordinary low radiation dose and rapid discharge of the labeled compound from the organism enables the use of radioisotope scanning for the investigation of children of any age. Radioisotope renography yields valuable qualitative and quantitative information of the function of each kidney separately. The renographic symptomatics in principal diseases of the kidneys are described. A total of 100 children was examined. The technique is recommended for wide practical use in pediatric nephrology. (auth)

38376 COMPARISON OF HIGH AND LOW DOSAGE LEVELS OF ^{131}I IN THE TREATMENT OF THYROTOXICOSIS. Hagen, Garrett A.; Ouellette, Robert P.; Chapman, Earle M. (Massachusetts General Hospital, Boston). New Engl. J. Med., 277: 559-62(Sept. 14, 1967).

Lower dose levels of ^{131}I were tested in attempts to reduce the occurrence of a serious complication of radioiodine therapy, namely the appearance of permanent hypothyroidism several years after treatment of thyrotoxicosis. Radioinduced hypothyroidism occurred in 25% of patients 2 yr after ^{131}I treatment with the usual doses, the rate steadily increasing to 40% after 10 yr in one study, and in 45% after 2 yr and in 70% by 10 yr of follow-up observation in another study. Radiation damage to the replicative capacity of the thyroid cell, leading to eventual depletion of the gland, is generally considered to be the underlying mechanism of this complication. Studies of irradiated rat thyroid cells revealed a decreased capacity for goitrogen-induced proliferation as compared to non-irradiated cells. When the postradiation thyroid-cell population is sufficiently diminished by the passage of time, hypothyroidism appears. This is a serious complication since it impairs physical and intellectual performance from the beginning and if untreated may eventually threaten life. Means of avoiding hypothyroidism were sought in an investigation designed to compare the results of treating patients with thyrotoxicosis with 2 dose levels of ^{131}I (80 and 160 μCi of ^{131}I/g of thyroid tissue). The mean total radiation dose to the thyroid gland in the 36 patients on the low dose, in whom the biologic half-life was determined by ion-chamber counts, was 5578 rad, and the mean dose to the rest of the body was 6.5 rad. The lower-dosage level of ^{131}I in the treatment of thyrotoxicosis was associated with a substantial reduction in the incidence of post-treatment hypothyroidism during the first 2 yr. No increase was seen in the number of patients requiring retreatment; the prolonged use of KI in patients with mild persistent toxicity frequently made retreatment unnecessary. Normal thyroid function was reached by 4 months after treatment with the lower dose of ^{131}I, in 77% of the patients. (BBB)

38377 EXPERIENCE IN SHORT-DISTANCE X RAY THERAPY OF CANCER OF THE SKIN. Alieva, I. G. (Moscow Scientific Research Inst. of Oncology). Med. Radiol., 13: No. 5, 15-21(May 1968). (In Russian).

Observation was made on 340 patients with skin cancer after short-distance and teleroentgen-therapy. In all patients there was noted an immediate recovery, but in 39 cases relapses occurred. The results of treatment primarily depended on the localization of the neoplasm. Patients with skin cancer in the region of eyelids, eye corners, and scalp, manifested an initial form of the disease and immediately recovered. Less favorable results were in tumors of the external ear and forehead (26.6 and 17.2% of relapses). The main cause of relapses was discrepancy between the size of irradiation fields and true borders of tumor spread. During the use of small fields the zone of possible tumor spread was irradiated insufficiently, or not at all. In view of this, it is suggested that for short-focus teleroentgen-therapy of skin cancer one should include surrounding tissues not less than $1\frac{1}{2}$ to 2 cm from the tumor edge in the irradiation field. (auth)

38378 EXPERIMENTAL USE OF CONVALESCENT BLOOD IN ACUTE RADIATION SICKNESS. Chevlytko, A. A. (Minsk Medical Inst.). Med. Radiol., 13: No. 5, 21-4(May 1968). (In Russian).

In experiments on 64 dogs subjected to x radiation at a dose of 600 R the possibility of using convalescent blood in the treatment of acute radiation sickness was investigated. Convalescent donors were dogs that had sustained acute radiation sickness and recovered following active treatment. It was found that convalescent blood used for blood substitution (25%) at the end of the latent period of acute radiation sickness (7th to 9th day after irradiation) did not cause post-transfusion reactions. The therapeutic effect of convalescent blood was not inferior to transfusion of the blood of healthy donors. (auth)

38379 SOME EFFECTS OF BINDING AGENTS ON THE X IRRADIATION OF DNA. Brown, P. E. (Univ. of California, Berkeley). Radiat. Res., 34: 24-35(1968).

Some effects of x irradiation on the melting temperature of DNA bound with normal aliphatic diamines, cystamine, and β,β'-diaminodiethylsulfide were examined. The T_m decreased linearly with dose for doses below 180 krads, the gradient being used as a measure of the protective capacities of the various binding agents. Some protection of the DNA against denaturation arose from the physical presence of the bound diamines, since the aliphatic diamines diaminohexane through diaminodecane gave significant protection. A chain-length dependence of this protection was observed, the maximum effect occurring with diaminononane. In situ radical scavenging was also effective. Cystamine was not found to be a better protector than β,β'-diaminodiethylsulfide or diaminononane. Thus these effects were not sufficient to account for the differences in the capacities of the compounds to protect in vivo systems against ionizing radiation, and this implies that further factors, possibly more biological in nature, are involved in in vivo radioprotection. (auth)

38380 A NEW AFTERLOADING TECHNIQUE FOR INTERSTITIAL IRRADIATION USING RADIOACTIVE MICROSPHERES. Chary, K. K. N. (Univ. of Minnesota Hospitals, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 193-8 (Jan. 1968).

Problems inherent in the currently employed methods of interstitial implantation of radioactive materials for therapeutic purposes are discussed. To eliminate some of these difficulties, a new uncomplicated technique was developed. The method is described. Advantages of the method were listed as follows: the implant is permanent; the radioactive sources are nonmetallic and are not rigid; the procedure can be employed in relatively inaccessible sites; and the dose to the operator and operating room personnel is low because an after-loading technique is used. This method was found to be especially valuable in debilitated patients and in those with lesions difficult to treat by conventional means because of anatomic factors, prior radiation therapy, or both. (auth)

38381 BIOLOGIC BASIS OF PREOPERATIVE RADIATION TREATMENT. Powers, W. E.; Palmer, L. A. (Washington Univ., St. Louis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 176-92(Jan. 1968).

A biologic basis of preoperative radiation treatment is presented and factors governing its application are discussed in detail. Emphasis is given to the construction of a rational basis for the use of preoperative radiotherapy to increase the cure rate of cancer, a suggested mechanism by which irradiation might lead to benefit without undue increase in complications, and support of the validity and applicability of these theoretical considerations by experimental evidence. (TSS) (auth)

38382 OXYGEN AND L-TRIIODOTHYRONINE IN RADIOTHERAPY OF MOUSE TUMORS. Du Sault, Lucille A. (Henry Ford Hospital, Detroit). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 43-5(Jan. 1968).

Mice receiving radiotherapy of breast tumors, after having been made hyperthyroid by T3 medication or while breathing 95% O_2 + 5% CO_2, showed an increased cure rate over mice treated while breathing air, but without increased systemic effects. When both T3 and O_2/CO_2 were used, the death rate during treatment was doubled and the cure rate was not improved. In some situations T3 medication may be superior to oxygen at high pressure as a means of improving oxygenation of tumor cells during radiotherapy, while in other situations it may be inferior. (auth)

38383 HYPERBARIC OXYGEN IN RADIATION THERAPY. AN INVESTIGATION OF DOSE-EFFECT RELATIONSHIPS IN

TUMOR RESPONSE AND TISSUE DAMAGE. van den Brenk, H. A. S. (St. Thomas' Hospital, London). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 8-26(Jan. 1968).

Results are reviewed from experimental studies in animals on the effects of oxygen on the radiosensitivity of tumors. Data are presented from clinical studies in which hyperbaric oxygen was administered during x radiotherapy of neoplasms in man. It was concluded that hyperbaric oxygen improved the effectiveness of radiotherapy for primary tumors and lymph node metastases. (67 references.) (C.H.)

38384 RADIATION THERAPY ADMINISTERED UNDER CONDITIONS OF TOURNIQUET-INDUCED LOCAL TISSUE HYPOXIA. Suit, Herman; Lindberg, Robert (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 27-37(Jan. 1968).

Results of radiotherapy administered under conditions of tourniquet produced hypoxia to a group of 44 sarcomas of bone and soft tissue of the distal extremities are presented. Twenty-two osteosarcomas were treated and the local control results at about 12 months were: 1/3 at 12,000 RADs in 36 days, 1/4 at 14,000 RADs in 43 days, and 3/3 at 16,000 RADs in 50 days. Late reactions of normal tissues were so severe after 16,000 RADs that the treatment method was not considered to be a clinically effective method for therapy of osteosarcomas. Much better results were obtained in a group of 18 soft tissue sarcomas. Local control results at about 12 months were 3/4 at 12,000 RADs and 9/9 at 14,000 RADs. Normal tissue reactions in these patients at 14,000 RADs were considered to be quite acceptable. (auth)

38385 THE EFFECT OF α-THIOLA IN RADIOTHERAPY. Tedo, Toru (National Sendai Hospital). Shinyaku To Rinsho, 15: 1187-9(Sept. 1966). (In Japanese).

In 40 cases of malignant tumors irradiated by ^{60}Co γ rays with a massive dose (7500 to 12000 R), Thiola-tablet was administered per os with a daily dose of 300 mg, and its effect on the induction radiation sickness and leukopenia was studied. The results indicated that Thiola was effective in 72.5% of the cases for the prevention of radiation sickness. When administered in combination with other medicines, the previously planned radiotherapy could be completely conducted in 92.5% or 37 of 40 cases. In only 3 (7.5%) of 40 cases, severe radiation sickness appeared and radiotherapy was discontinued. Thiola seemed to be considerably effective in the prevention of radiation sickness. When the leukocyte count at the end of radiotherapy was compared with that before irradiation, 17 cases (42.5%) showed a decrease of more than 1000, 9 cases (22.5%) showed a decrease of more than 2000, and only 2 cases (5%) showed a decrease of 3000 and more. There was no case in which the leukocyte count was reduced to below 3000. Thiola seemed to be effective for the prevention of leukopenia. (NSA of Japan)

38386 RADIATION DOSE: TUMOR CONTROL ASSAYS FOR IRRADIATION THROUGH A SIEVE. Urano, Muneyasu; Kaneda, Hiromu; Shimazaki, Shozo; Hayashi, Shigejiro (Kyoto Prefectural Univ. of Medicine). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 38-42(Jan. 1968).

The relationship between the tumor control frequency and the radiation dose for x radiation treatment of a solid Ehrlich ascites carcinoma in mice by open field technique and sieve technique is presented. The TCD_{50} (dose to control half of the tumor) was found to be higher for the sieve than for the open field method. The TCD_{50} (70 days) was 4,751 rads by the sieve technique and 3,871 rads by the open field technique. The ratio of TCD_{50} sieve/open field was 1.23. The reaction of normal tissue surrounding the tumor to a dose producing a given tumor control frequency was markedly less if that dose were administered through a sieve than if through an open field. The radiation dose that induced skin retraction was >1.8 times higher by the sieve techniques than by the open field techniques. (auth)

38387 RESEARCH ON THE DOSIMETRY OF POINT-SOURCE RADIOACTIVE PARTICLES. Schmidt-Burbach, G. M. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). pp 669-79 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In German).

See EUR-3747; CONF-671109.

The deposition of radioactive compounds in the organism occurs partly non-homogeneously with the formation of hot spots. This non-homogeneity of the radiation exposure must be taken into account in the dosimetry of the affected tissue. For this purpose a method is described to determine the dose distribution experimentally in the neighborhood of a β-active particle. In this connection the production of small radioactive particles and the calibration of a partially irradiated LiF-single crystal for measurement of thermoluminescence, is described. (auth)

38388 THE CLINICAL USE OF SODIUM FLUORIDE ^{18}F IN BONE PHOTOSCANNING. Moon, Norman F.; Dworkin, Howard J.; LaFluer, Philip D. (Univ. of Michigan, Ann Arbor). J. Amer. Med. Ass., 204: 974-80(June 10, 1968).

Thirty-eight patients were given 350 μCi to 750 μCi of ^{18}F-sodium fluoride. The nuclide was administered both orally and parenterally. Photoscans were performed in 35 cases, and point counts only were done in the other three. Diagnostic scans were found at all dosage levels given. Normal scans were found in cases of osteochondroma, soft-tissue sarcomas, rheumatoid spondylitis, Engelmann's disease, and aseptic necrosis of femoral heads. Abnormal scans were found in 25 cases including four cases of metastatic bone tumors in which roentgenograms were either normal or equivocal. The radionuclide was found to be well tolerated. The radiation hazard with ^{18}F-sodium fluoride is minimal, and serial scans were performed successfully in several patients. (auth)

38389 THE COLORED SCINTIGRAM (MULTISCINTIGRAM SYSTEM). Ozeki, M.; Furukawa, Y. (Kurume Univ., Japan). pp 1141-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A Multiscintigram System as a new method of scintigraphy was devised. It consists of the Multi-Section method, the Multi-Factor method and the color scintigram. Multi-Section scintigraphy is the initial step in color scintigraphy, so that these two elements cannot be separated. The features of this system are such that it is possible to obtain useful information for clinical diagnosis by only one scan examination (the latitude of scintigraphy is very wide). Furthermore, a quantitative analysis is possible with both the Multi-Section and the color scintigram. The method was used clinically in the diagnosis of brain tumors, diseases of the lung, liver, kidneys, and thyroid gland and its value was shown to be much higher than that of the monochromatic methods, and that the percentage of correct diagnosis is much higher. It was also confirmed that this method can be used to some extent to test the function of the liver and kidneys. (auth)

38390 THREE-DIMENSIONAL IMAGE RECONSTRUCTION IN SCANNING AND RADIOGRAPHY. Harper, Paul V. (Univ. of Chicago). pp 1137-40 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The use of the Anger Scintillation Camera and the ^{99}Mo-^{99}Tc-generator in scanning and radiography are discussed. In the process of transverse section scanning, linear picture elements derived from scanning information were used to build up an image of excellent detail and resolution. The desired section was scanned linearly along the edge in the plane of the section with registration of the observed counts as linear elements parallel to the detector axis. A modification of this principle for producing a three-dimensional image is described. (H.L.W.)

38391 PRESENT-DAY RADIATION THERAPY OF BRAIN TUMORS. Ugryumov, V. M.; Badmaev, K. N.; Tchaika, T. V.; Smirnov, R. V.; Volkov, A. A.; Samoilov, V. J.; Sinitsina, A. P.; Zenkovich, S. G. (Polenov Neurosurgical Inst., Leningrad). pp 1018-20 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Eighty-three patients were treated with high-energy x rays, and 120 were treated by the introduction into the tumor of ^{198}Au in the granular or colloidal form, ^{32}P, and ^{90}Y. In most cases radiation treatment was combined with surgery. High-energy x rays were used in the treatment of deeply situated solid tumors of the brain. By comparison with conventional radiotherapy, the use of high energy x rays made it possible to increase the focal dose of radiation and diminish the integral dose. This resulted in broadening of the indications for radiotherapy. The increased focal dose had a favorable effect on the results of treatment so that the average life span of patients with malignant brain tumors was doubled. The clinical course and life span of tumor patients under treatment with high-energy radiotherapy depend on the histological structure and the volume of the tumor, the extent of surgical intervention, the mode of distribution of the focal dose, and the duration of the intervals between courses of radiotherapy. Colloidal radioisotopes were used exclusively for intracavitary irradiation of cystic and ventricular tumors, and tumors metastasizing via the cerebrospinal fluid pathways. Treatment with radioactive isotopes in cases of intratissular or intracavitary

radiation of tumors showed good results when they were comparatively benign. Of 48 patients with solid cerebral tumors treated with colloidal ^{198}Au, 19 had remissions of symptoms for 2 to 5 years. Favorable results were obtained in treating craniopharyngiomas. Of 16 patients treated, 12 gave positive results and in five the remissions lasted two to eight years. (H.L.W.)

38392 PROGRESS IN RADIOLOGY. SYMPOSIA AND INVITED PAPERS OF THE XIth INTERNATIONAL CONGRESS OF RADIOLOGY, ROME, 22-28 SEPTEMBER, 1965. VOLUME II. Turano, L.; Ratti, A.; Biagini, C. (eds.). International Congress Series No. 105. New York, Excerpta Medica Foundation, 1967. 1025p. (In Several Languages). (CONF-650907-(Vol.2)).

Separate abstracts were prepared on 74 papers. Fifty-nine additional papers discuss additional aspects of progress in radiology. (C.H.)

For abstracts of individual papers see: 38055, 38056, 38231-38235, 38243-38246, 38304, 38320-38333, 38389-38391, 38393-38416, 38481-38498, 38507, 39147, and 39536.

38393 SIMULTANEOUS FUNCTION DIAGNOSTICS WITH RADIONUCLIDES. Graul, E. H.; Hundeshagen, H.; Kuni, H. (Philipps-Univ., Marburg, Ger.). pp 1247-58 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The use of radioisotope scanning procedures, combined with clinical measurements of chemical and physical factors, for the measurement of physiological processes in man is discussed. Examples cited include the use of data from radioisotope scans together with data on arterial blood pressure, pulse rate, venous pulse, and electrocardiogram for the diagnosis of cardiovascular diseases; the use of simultaneous measurements of radioactivity in various parts of the body following the administration of a radioisotope for determining rapid distribution processes; and use of two or more radioisotopes or labeled compounds to measure two or more physiological processes simultaneously. The advantages of the use of computers for data processing and the correlation of information are discussed. (C.H.)

38394 PROBLEMS OF RADIOISOTOPIC VISUALIZATION OF COLD NODULES. Fava, G.; Roncoroni, L. (Univ., Milan, Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan. pp 1232-44 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The analysis of 4,000 scans of organs in human and phantom patients, including initial black-and-white scans, later black-and-white records complete with photoscanning, and color scans, afforded an opportunity of reviewing the range of usefulness of these instruments. Color scanning undoubtedly has an advantage over black-and-white in showing up the levels of activity in an organ, although adjustment of the instruments requires greater technical skill and experience. However, the descriptive efficacy of color is not always sufficient to document the shape and size of a non-radioactive area. It was shown experimentally how difficult it is to differentiate a sphere from a cylinder with a base diameter the same as the diameter of the sphere. Only by repeating the investigation with different cut-off values is it possible to differentiate the 2 geometrical shapes; with magnetic recording this distinction is immediate, allowing only for the time taken to process the findings. For studying organs such as the liver and the kidneys, color recording is unlikely to yield at the first attempt sufficient information regarding nodules at a given site and of a given size. The results may be better if the investigation is repeated under technically altered conditions, but this entails considerable discomfort for the patient. With the magnetic recording method, the processing can be done without repeating the examination. The ideal instrument would be one that produces colour scans and processes the data stored, the latter whether the patient is there or not. (auth)

38395 ALTERATION OF THE QUANTITATIVE DISTRIBUTION OF RADIOACTIVE MATERIALS AS AN INDEX OF HEPATIC CIRRHOSIS. Gomez Cresop, G.; Christie, J. H.; Koch-Weser, D.; Macintyre, W. J. (Highland View Hospital, Cleveland). pp 1223-31 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Forty-six patients with a previous diagnosis of cirrhosis of the liver were studied using ^{198}Au colloids and scintillation counters. Prolonged clearance time following the administration of colloidal ^{198}Au, together with spleen visualization and perihilar accumulation was almost invariant in severe examples of liver impairment from cirrhosis, with these characteristics decreasing in incidence as impairment of function was less severe. The early indications of proliferation around the hilus and decreased peripheral distribution were found to be extremely useful in identifying early minimal effects of this disease. (C.H.)

38396 THE PRESENT STATE OF SPLEEN DIAGNOSTICS WITH RADIOACTIVE ISOTOPES. Fischer, J. (Johannes Gutenberg-Univ., Mainz). pp 1216-22 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Scintigraphy is a new clinical technique by which the shape, size and position of the spleen can be demonstrated with absolute reliability. There are two methods of carrying it out, viz., injection of erythrocytes labeled with ^{51}Cr and altered by heat; and injection of blood incubated with ^{197}Hg-BMHP. Both methods are suitable for routine examinations and can be used even in dangerously ill patients. More than 1,500 patients have been personally examined without any complications or incompatibility reaction being demonstrated. A quantitative estimate of the size of the spleen can be made by a determination of its surface area. Information concerning splenic function may be gained by measuring either the radioactivity in the blood following injection of ^{51}Cr-marked erythrocytes that have been altered by heat or the accumulation of activity in the spleen. For the first time it has been possible to demonstrate quantitatively a function of the spleen. (auth)

38397 ISOTOPIC EXAMINATION OF THE BRAIN. Marryat, J. F.; Bull, J. W. D. (National Hospital for Nervous Diseases, London). pp 1213-15 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results of several hundred radioisotope scans performed for the diagnosis of brain lesions are reviewed. The advantages and disadvantages of using ^{203}Hg-neohydrin, ^{131}I-polyvinyl-pyrrolidone, ^{197}Hg-neohydrin, and ^{99}Tc for brain scanning are discussed. Neohydrin labeled with ^{197}Hg was selected for routine use since it gave a good brain scan and appeared to be completely safe. All radioisotope scans were immediately correlated with x ray films, angiograms, and pneumo-encephalograms, and results of other clinical studies and all collected evidence was used in arriving at the final diagnosis. It was concluded that brain scanning reinforces rather than replaces other neuro-radiological procedures used for the diagnosis of brain lesions. (C.H.)

38398 RADIOISOTOPE METHOD OF EVALUATION OF IMPAIRMENT OF REGIONAL MYOCARDIAL BLOOD SUPPLY. Rejali, Abbas M.; Friedell, Hymer L.; Gregg, Earle C. (Western Reserve Univ., Cleveland). Contract W-31-109-eng-78. pp 1208-12 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Attempts to utilize radioisotope techniques for visualization of the myocardium were made by several investigators and the use of different materials was explored. Cesium-131 in the form of cesium acetate appears to be the material of choice. Although differential deposition of ^{131}Cs in normal myocardium as compared to an infarcted area is large, these differences are often obscured because of the deposition of radioelements in overlying structures. The total information scanner, permitting numerous presentations with varying controlled erase levels and controlled contrast enhancement, appears to be particularly effective in these studies. Although experience with the myocardial scan is still limited, it is felt that this simple technique in conjunction with electrocardiogram and serum enzyme changes will provide the clinician with important information for better evaluation of myocardial infarction and regional impairment of coronary circulation. (auth)

38399 LUNG VISUALIZATION AND FUNCTIONAL EVALUATION BY TWO NEW RADIOISOTOPE SCANNING METHODS. Taplin, George V.; Dore, Earl K.; Poe, Norman D.; Greenberg, Alfred; Johnson, DeLores E. (Univ. of California, Los Angeles. Los Angeles County Harbor General Hospital, Torrance; Los Angeles County Olive View Hospital, Olive View, Calif.; Memorial Hospital, Long Beach, Calif.). pp 1194-1207 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

More than 1200 ^{131}I lung scans were performed in patients with a variety of pulmonary diseases. No reactions to the macro-aggregated albumin preparations were encountered even in seriously ill patients with massive pulmonary embolism, severe emphysema, congestive heart failure or with cardiac shunts. The lung scan has the unique capacity to indicate the site and magnitude of pulmonary embolism before evidence of pulmonary ischemia or infarction are recognizable radiographically. The development of a safe technique for visualizing the lower respiratory tract by chest scanning following inhalation of suitable radioaerosols is described. The aerosolization equipment and test agents are readily available. Filtration of the exhaled air and channeling it to a vented hood or to the outside atmosphere prevents contamination of the examining room and personnel. Normally, inhaled radioactive particles smaller than 1 to 2 μ are evenly distributed throughout the lungs and penetrate to the distal alveoli. Inhalation and intravenous lung scans have nearly identical patterns in normal subjects. The inhalation scan pattern represents the distribution of airborne particles deposited throughout the lower respiratory tract but the amount of radioactivity in any given portion of the lung is not always proportional to air flow to that region. Aerosol deposition is related to factors other than diffusion such as particle size, sedimentation, impaction, concentration of aerosol and the rate of air movement. When inhalation is performed with the subject in the lateral position, greater amounts of aerosol are deposited in the superior lung where ventilation and perfusion are reduced. With partial bronchial obstruction, increased deposition of radioaerosol may occur at the obstruction site and the region beyond usually shows reduced levels of radioactivity. Complete bronchial obstruction is readily detectable in the inhalation scan as an area devoid of radioactivity and a normal lung image indicates patency of the lower respiratory passages. The radioaerosol inhalation scanning procedure is a useful adjunct to bronchography in the assessment of airway patency. It may be employed safely when bronchography is contraindicated as in patients with impaired pulmonary function. The procedure is still in the early stages of development but current experience with it warrants further investigation and technical improvements. (auth)

38400 DETECTION OF BONE LESIONS WITH A SPECIAL HIGH EFFICIENCY SCANNER. Centi Colella, A.; Cantarano, G.; Pigorini, F. (Univ. of Rome). pp 1179-93 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A special apparatus for scanning and counting was assembled to obtain high efficiency in detecting ^{47}Ca and ^{85}Sr. The apparatus possesses two identical opposed detector heads that are mobile only along the collimation axis; they are mounted above and below the patient's bed. Each detector is provided with a scintillation crystal shielded by a lead layer 16 cm thick. The photomultiplier tube and the crystal are mobile inside the steel casing; therefore collimators of varying thickness can be used; this device permits the scanner to be utilized also for detecting low-energy isotopes. An x-ray tube, connected to the system, allows radiographs to be taken with the patient in the same position as during scanning, and the apparatus is so arranged that the scan can be superimposed on the x-ray film. Scanning is carried out with lead focusing collimators that offer in the focus zone the best compromise between geometrical efficiency and resolution. Graphs and photographs are presented to show results of the use of this instrument. Results of investigations with radioisotopes increase the diagnostic possibilities in lesions of the skeleton when they are correlated with the clinical, laboratory, and radiological findings. (H.L.W.)

38401 THE QUANTITATIVE ANALYSIS OF SCINTISCAN DISPLAYS OF THE BRAIN, IMPROVEMENTS TO A GAMMA CAMERA, AND A PHANTOM TECHNIQUE TO INTERCOMPARE THE PERFORMANCE OF RADIOISOTOPE SCANNING MACHINES. Mallard, J. R. (St. Thomas's Hospital Medical School, London). pp 1171-8 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A grid system based on external bony features of the skull was devised for quantitative analysis of scintiscan displays of the brain. The normal count rate pattern for radioactive arsenic was determined by considering the scans of six patients with no known space-occupying lesion. Improvements in the gamma camera include extraction of quantitative information from the displayed picture on the cathode ray storage tube. Improvements in resolution were tested as a result of using logarithmic difference amplifiers instead of the usual linear difference amplifiers in the positioning signal circuits of the Anger-type image transfer system. The size of the image on the display is virtually independent of gamma energy, thus improving resolution when looking at a body emitting a spread of energies. A phantom technique was developed for comparing the performance of radioisotope scanning machines. Experiments were carried out to test calculations by scanning discs of radioactivity in a Mix D phantom in the presence of a radioactive background count rate. A large number of scans were performed at different levels of surrounding background count rate, at different depths in phantom for different diameter of disc. (H.L.W.)

38402 COMPUTER SCINTIGRAPHY. Winkler, C. (Chirurgische Univ., Bonn-Venusberg, Ger.). pp 1165-70 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The principles of a system that was developed for automatic transmission, punch recording, computer processing and digital read-out of scanning data are presented. The advantages of the device, when compared with conventional scanners, are described by means of examples of its clinical and experimental application. Future aspects of the Computer Scanning Method are briefly discussed. (auth)

38403 SCINTIGRAPHY WITH RADIOACTIVE MERCURY IN THE MORPHOLOGICAL AND FUNCTIONAL STUDY OF THE KIDNEY. Martinenghi, C.; Meldolesi, U. (Univ. of Milan). pp 1278-87 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The possibility of reducing exposure by promoting a more rapid elimination of mercury and by replacing the mercury compounds with ^{131}I-labeled-hippuran was studied. The curve of mercury accumulation in the human kidney shows that 30 days after administration the kidney still contained 15% of the highest concentration present about two hours after the intravenous injection. Experiments with rats showed that the excretion curve could be divided graphically into two exponential functions; of these, one decreased rapidly and the other much more slowly. If the quantity of radiomercury administered was increased, the renal concentration also increased progressively. In man even when only tracer doses were administered and when renal fixation was pathologically decreased, the radiomercury tended to accumulate in other tissues (first in the liver). Results are presented in graphic form. (H.L.W.)

38404 DETECTION OF TUMOURS IN MAN BY MEANS OF ^{131}I-FIBRINOGEN. Monasterio, G.; Becchini, M. F.; Riccioni, N. (Univ. of Pisa, Italy). pp 1270-7 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

From this study it appears that, of all the indicators used, only ^{131}I-fibrinogen allows the specific behavior of malignant neoplasms with respect to other lesions to be differentiated. This property of radioiodinated fibrinogen in comparison with Sari and ^{203}Hg neohydrin seems to be attributable (according to a personal experiment which has been previously reported) to its biological peculiarities, that is, to its conversion into fibrin on the site of the lesion. The method presented here is highly sensitive and allows malignancies to be detected in the great majority of cases, within the limitation started with regard to the site of the lesion. Moreover, this method, unlike those based on the use of other gamma-emitting indicators, seems to possess a marked specificity which allows malignant neoplasms to be differentiated from highly-vascular benign tumors and from inflammatory processes. (auth)

38405 WHOLE-BODY COUNTERS AND THEIR CLINICAL APPLICATIONS. Muth, H. (Univ., des Saarlandes, Homburg/Saar, Ger.). pp 1317-25 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Clinical applications of whole-body counters are discussed. Examples discussed include the distribution of tracer doses of ^{131}I or ^{59}Fe in the various tissues of man, measurements of ^{40}K as an index of lean body mass, and studies on the metabolism of

vitamin B_{12} labeled with ^{58}Co or ^{60}Co. Measurements of the whole-body content of fallout ^{137}Cs are also discussed. (C.H.)

38406 SOME INVESTIGATIONS WITH A MULTI-CRYSTAL WHOLE-BODY SPECTROMETER. Trott, N. G.; Cottrall, M. F. (Royal Cancer Hospital, London. Royal Marsden Hospital, London). pp 1307-16 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The importance of investigating thoroughly the physical characteristics of the counting system used for radioisotope scanning of patients is discussed. Methods are described for evaluating the performance of a multi-crystal γ spectrometer for whole-body counting that will prove useful in the systematic comparison of the various low activity in vivo counting techniques now being developed and widely adopted for clinical work. (C.H.)

38407 CHEMICAL PROTECTION OF MAMMALIAN CELLS AGAINST IONIZING IRRADIATION. Vos, O.; Vergroesen, A. J. (National Defense Research Organization, TNO, Rijswijk, Netherlands). pp 1598-1603 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Protection against γ and x radiation was observed with a number of different agents. Survival could be increased by making cells anoxic. It was found that the protective effects of cysteamine were considerably lower under anoxic conditions than in air. The importance of this finding in radiotherapy is that since the tumor cells are often anoxic, the normal tissue cells are better protected in comparison to the tumor cells. Good protection was found from SH compounds, e.g., cysteamine, cysteine and AET. Some agents with the ability to replace intracellular water gave protection, e.g., glycerol and dimethylsulfoxide. Protection was shown when cells were frozen to very low temperatures. No protection was found with histamine, epinephrine, serotonin, other amines, or with disulfides. Studies on pH showed that the compounds cysteamine, cysteine, and thioglyol gave better protection in a more alkaline medium. The relation between the degree of protection and the dissociation value of the chemical was given in tabular form for cysteamine, cysteine, glutathione, thioglyol, homocysteine, thioglycolic acid, and penicillamine. (H.L.W.)

38408 PROPHYLAXIS AND TREATMENT OF RADIATION-INDUCED INJURIES. Gorizontov, P. D.; Rogozkine, V. D. (Inst. of Biophysics, Moscow). pp 1593-7 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The relation between the development of radiation sickness and the state of the hematopoietic system is discussed. In experiments with irradiated rats, the protective effects of mercaptoethylamine were manifested by an increase of 45% in survival; however, at the stage of initial exhaustion the protective effects of mercaptoethylamine were absent. The importance of the physiological state of the organism in determining the effectiveness of the protective agent is emphasized. Following administration of radioprotective compounds to dogs, hypoxia in hemopoietic tissues was observed and a very pronounced hypoxia occurred in the brain. The effectiveness of therapy was augmented by administration of vitamins before irradiation. Experiments with γ- and x-irradiated dogs fully confirmed the simultaneous use of prophylactic and therapeutic measures. (H.L.W.)

38409 CERTAIN ASPECTS OF THE PREVENTION AND TREATMENT OF RADIATION DAMAGE IN MAMMALS. Bacq, Z. M. (Univ., Liege). pp 1590-2 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Enzyme repair mechanisms of DNA strands following damage by uv or ionizing radiations are discussed. If a large percentage of cells from a given tissue are severly damaged and cannot be repaired, the lytic enzymes, that are normally inactive because they are linked with certain intracellular structures, are liberated and progressively fragment the macromolecules that maintain structure and activity. The nucleotides, nucleosides, and polypeptides resulting from this lysis are highly concentrated in the dying cell. After homogeneous x radiation of the whole body, the speed at which lesions appear and are repaired differs from organ to organ; a mouse may die from bone marrow destruction when the intestinal epithelium has regenerated perfectly. Mechanisms of protection against radiation damage by chemical compounds are discussed. Conditions of mammals in which increased resistance to radiation is associated with increased fat consumption or abnormal carbohydrate metabolism are as follows: natural hibernation, fasting, cold acclimatization, cysteamine injection, and fluoroacetate poisoning. (H.L.W.)

38410 INFLUENCE OF OZONIZED AIR IN RADIOSENSITIVITY. Brinkman, R.; Veninga, T. S. (Univ. of Groningen, Netherlands). pp 1466-8 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results are reported from studies on the effects of ozone (0.2 ppM) on the survival of mice following exposure to 675 R x radiation. A marked effect of ozone on radiosensitivity was shown. Factors controlling the natural and artificial activation of dissolved oxygen in animal tissues are outlined and data on the distribution of respired ozone in tissues and the toxicity of ozone in man are reviewed. The possibilities of using ozone to increase the radiosensitivity of neoplasms during radiation therapy in man are discussed briefly. (C.H.)

38411 COMPARISON OF THE RESULTS OF TREATMENT OF LUNG TUMORS WITH CONVENTIONAL AND HIGH-ENERGY RADIATIONS IN DJAKARTA, INDONESIA. Rasad, B. Sjahriar (Univ. of Indonesia, Djakarta). pp 1991-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results of treatment of lung tumors with conventional 200 KV x rays are compared with those obtained using ^{60}Co γ radiation. The results of treatment suggest that high-energy radiations, though superior to conventional 200 KV x rays in some respects, e.g., a shorter total treatment time, do not, on the whole, improve significantly the overall survival time of cases of lung cancer. All cases treated by conventional 200 KV x rays died within six months of the start of treatment. Almost all cases treated with γ radiation died within one year of the start of treatment but one patient survived for seven years. (auth) (TSS)

38412 EXPERIENCE IN THE TREATMENT OF CARCINOMA OF THE LUNG WITH THE 31 MeV BETATRON (1955–1964). Ravnihar, B.; Cebin, B.; Zitnik, D. (Inst. of Oncology, Ljubljana, Yugoslavia). pp 1936-42 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results are reported on 190 cases of inoperable bronchogenic carcinomas treated with supervoltage x-ray beams produced by a 31 MeV betatron. Thirty-four patients received a total dose of 3,000 to 5,000 rads, and 156 received 5,000 rads or more. Data are presented on the survival rates of the patients after the beginning of treatment. Out of three patients with microscopically-determined malignancies, two survived seven years and one survived eight years, while 72% of the patients treated with doses of 5000 rads survived for six months. (C.H.)

38413 BASIS FOR THE UTILIZATION OF OXYGEN EFFECT IN RADIOTHERAPY. Withers, H. Rodney (Mount Vernon Hospital, Northwood, Eng.). pp 1458-65 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Facts basic to the use of oxygen in radiotherapy of neoplasms are reviewed. Criteria for selection of tumors for treatment include: tumors with enough anoxic cells to render them incurable by routine radiotherapy when the patient breathes air; possibility of eliminating anoxic cells from the tumor; and the proportion of anoxic cells in normal tissues must be less than in tumors. The cause of anoxia in tumors and the effects of hyperbaric oxygen on normal tissues are discussed. Present knowledge is reviewed and it is concluded that the use of hyperbaric oxygen during radiotherapy will increase the cure rate for some intermediate tumors that will not be cured otherwise. (C.H.)

38414 PROTECTIVE EFFECT OBTAINED BY INFRARED IRRADIATION OF THE SUPRARENAL REGION OF WHITE MICE EXPOSED TO A LETHAL DOSE OF ^{60}Co γ RADIATION. Retzepis, Georges (Univ., Athens). pp 1629-33 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol. 2).

Infrared irradiation in adequate doses to the adrenal region of mice before lethal whole-body irradiation of the animals with ^{60}Co γ resulted in prolongation of survival time, as compared with that of the control animals, which were irradiated only with the lethal dose of ^{60}Co γ rays. This can be explained as a protective effect against γ irradiation damage by ^{60}Co, produced probably by stimulation of the adrenal cortex by infrared irradiation to the adrenal region of the animals. (auth)

38415 EXPERIMENTAL INVESTIGATIONS ON THE THERAPY OF LETHAL RADIATION INJURIES. Barth, G. (Wilhelm Conrad-Roentgen-Klinik, Giessen, Ger.). pp 1624-8 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Groups of mice were treated with various drugs following exposure to doses of 500 to 1000 R of ^{60}Co γ radiation. The effects of Aktihaemyl, Complamin, Rutin, Wobe-Mugos, vitamin B_{12}, and compounds of folic acid and oleic acid on the survival time of the irradiated mice were measured. Data are tabulated. (C.H.)

38416 OXYGEN SATURATION OF TUMOR CELLS TO INCREASE THE EFFECT OF INTERNAL RADIATION. Grady, Edgar D.; Nolan, Thomas R.; Grady, Charlotte; Daughtrey, William (Piedmont Hospital, Atlanta). Contract AT(40-1)-3096. pp 1469-75 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Treatment of lung tumors of New Zealand rabbits with intravenous administration of ^{90}Y-oxide sized particles was an effective method of decreasing the tumors. When this method was used, a greater control of the cancer was effected when the animals were exposed to high pressure oxygen (90% oxygen at three atmospheres absolute) twice daily for ten days. (auth)

Radiation Effects on Animals

Refer also to abstracts 38184, 38189, 38196, 38197, 38200, 38205–38207, 38212, 38216, 38217, 38219, 38221, 38223, 38226, 38227, 38243–38246, 38249, 38251, 38262, 38263, 38275, 38277, 38284, 38285, 38296, 38303, 38320, 38329, 38336, 38350, 38352–38355, 38358, 38364–38366, 38369, 38376, 38385, 38386, 38409–38412, 38414, 38416, and 38824.

38417 (ACRH-1000-59) CLINICAL CONSEQUENCES OF PROTRACTED EXPOSURE TO FALLOUT. Hasterlik, Robert J. (Chicago Univ., Ill. Dept. of Medicine. Argonne Cancer Research Hospital, Chicago, Ill.). May 1968. Contract AT(11-1)-69. 23p. (CONF-680507-3). Dep. CFSTI.

From Conference on Radiological Protection of the Publich in Nuclear Mass Disasters, Interlaken, Switzerland.

A summary of radiation effects on humans is presented, and tentative conclusions concerning clinical consequences of protracted exposure to fallout are drawn. It is estimated that the 60-day LD_{50} for man for acute exposure to fission product γ radiation is not greater than 450 R or 300 rads. Studies on patients receiving radiotherapy and accident victims treated at the Oak Ridge Institute for Nuclear Studies are discussed with regard to the relation of dose to responses such as malaise, anorexia, and death. The effects of continuous total-body irradiation of five members of a Mexican family exposed to ^{60}Co gamma radiation over a period of 106 days are reviewed; the clinical picture demonstrated by the single survivor was typical for an acute radiation dose of about 200 R. Studies carried out 11 and 12 years after the fallout exposure of the inhabitants of the Marshall Islands are reviewed, and evidence of severe thyroid disease ensuing from ingestion of fallout radioiodines that produced an acute external radiation dose of 175 rads is discussed. Data on late effects of deposition of ^{226}Ra in the human skeleton from studies on radium dial painters at Argonne National Laboratory are reviewed. The body burden of patients with bone sarcomas, neoplasmas of the skull, and leukemia ranged from 0.60 to 10.70 microcuries. Precise estimates of the hazards of ingestion of fallout ^{90}Sr are not as yet available. (H.L.W.)

38418 (BNL-12581) RELATION OF IRRADIATION DOSE-RATE EFFECTS IN MAMMALS AND IN MAMMALIAN CELLS. Bateman, J. L. (Brookhaven National Lab., Upton, N. Y.). [1968]. 20p. (CONF-680410-4). Dep. CFSTI.

From Symposium on Dose Rate in Mammalian Radiation Biology, Oak Ridge, Tenn.

Data of other investigators were utilized to derive and present certain features of mammalian cell and animal survival after exposure to ionizing radiations of low LET. Survival of cells tends, as it decreases, towards an exponential relation to dose. The dose to produce a constant level of survival tends, with decreasing survival, towards a linear relation to the reciprocal cube root of dose rate. Survival of small mammals, expressed in probits, appears to be linear on reciprocal dose. Regressions for various dose rates appear to be parallel. The dose to produce 50% survival bears a linear relation to the reciprocal cube root of dose rate. Species specificity appears to be expressed for animals by different slope constants (K) relating the LD_{50} to the reciprocal cube root of dose rate. Strain specificity appears to be characterized within one species by the infinite dose rate intercept of the extrapolated straight best fit line of LD_{50} on the reciprocal cube root of dose rate. A comparison of normalized and extrapolated survival characteristics on dose and dose rate from experiments with one strain of mouse cells and another strain of (whole) mice suggests coincidence of the animal LD_{50} with a particular (low) level of cell survival over the span of dose rates. As dose rate decreases, the ratio of cell/animal survival decreases for animal survivals of less than 50%, but with animal survivals greater than 50%, the ratio increases. In summary, an apparent disparity in dose-rate effect between cell systems, animal LD_{50}'s and high LD values, may be explainable by simple relationships made possible by comparison of the dose-survival curves as functions of dose rate. No mechanism is implicated by these relationships; rather, they serve as a framework within which subsequent pertinent data may be fruitfully examined. (auth)

38419 (CEA-R-3294) EFFETS DES ELECTRONS DE HAUTE ENERGIE SUR LA PEAU ET LES TISSUS SOUS-JACENTS DU LAPIN. ETUDE CLINIQUE ET HISTOLOGIQUE. (Effect of High-Energy Electrons on the Skin and Underlying Tissues of the Rabbit. Clinical and Histological Study). Legeay, Gerard; Vialettes, Henry; Adnet, Jean-Jacques; Court, Louis; Masse, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1967. 45p. (In French). Dep.

After briefly considering the mechanism of interaction between the electrons and matter as a function of their energy, the dosimetry carried out as a function of the irradiation device is described. The animals received surface doses of 5,700 to 22,100 rads in the thigh; the electron energy varied from 21 to 30 MeV. (auth)

38420 (CONF-660573-, pp 5-18) OCULAR EFFECTS OF LASER RADIATION ON MAMMALS. Ham, William T. Jr. (Medical Coll. of Virginia, Richmond).

Ocular hazards from lasers are discussed with particular reference to those associated with the retina of the eye. The structure and properties of the human eye and the relation of these factors to the ultimate effects of lasers are also discussed. A simple mathematical model of the heat conduction problem and for describing thermal injury in the retina is presented. (B.S.L.)

38421 (CONF-660573-, pp 35-48) INJURIOUS EFFECTS OF LASER RADIATION ON MAMMALS. Klein, Edmund (Roswell Park Memorial Inst., Buffalo, N. Y.).

Gross manifestations of the effects of laser radiation on mammalian organisms are outlined; this is accompanied by a discussion of the microscopic findings or biochemical changes. Most of the observations were carried out in mice, although hamsters, rats, rabbits, dogs, and monkeys were used. The areas of the animals that were irradiated were abdomen, brain, eye, head, liver, skin, fur, and skeleton. The effects of laser radiation on Harding–Passey melanomas in mice were also studied. (B.S.L.)

38422 (EUR-3939) NUCLEAR PYKNOSIS AND THE DEVELOPMENT OF RADIATION DAMAGE IN PERIPHERAL LYMPHOCYTES. Scaife, J. F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1968. 12p. Dep.

An evaluation of a system of biological dosimetry based upon the development of nuclear pyknosis in peripheral lymphocytes in vitro, showed the system to be reproducible in rats and rabbits with a linear response up to 100 R, and a sensitivity of 5 R with results available after 7 hours. With human lymphocytes 24 hours were required to produce an equivalent response which varied from individual to individual and hence can not be established as an overall invariable method of dosimetry. Rabbit lymphocytes labelled with ^{3}H-cytidine were found to disappear from the peripheral circulation very rapidly after reinfusion into the same animal. They were essentially all gone after 60–90 min and no difference in the rate of elimination could be discerned for normal or irradiated (200 R) lymphocytes. (auth)

38423 (K-1748) DSED: A DATA SET EDIT PROGRAM AND THE ALL MIGHTY MOUSE SUBPROGRAM. Brooks, Alfred A. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). June 24, 1968. Contract W-7405-eng-26. 101p. Dep. CFSTI.

The Data Set Edit Program and the set of subroutines used to process data for the All Mighty Mouse master tapes are described. The IBM 360 FORTRAN program is suitable for reducing and managing data which refers to an individual and which consists of several subtopics. The master data sets are constructed of self-describing records stored sequentially by the individual serial (identification) number. The records may be of variable content and variable structure as long as the basic underlying rational of the record format is retained. The master data set is intended for use in a subsequent sequential, conditional search and analysis program. The program contains capabilities to update, correct, delete and erase records or subtopics as well as to provide lists of various types, pooled data sets and a transaction log of all activity. The calling program is general and is made specific to any problem by the use of subroutines. The application to low level radiation data on mice is described. This report consists of the following sections: a description of the Data Set Edit Program, the specifications of the subprograms required to process data for the All Mighty Mouse master tapes, (including the pathology dictionary update program), a User's Guide and Setup Instructions, program lists of the main program and all subroutines including a skeletal input/output subprogram, and, sample input data. (auth)

38424 (N-68-18954) RELATIONSHIPS BETWEEN CELL POPULATION KINETICS AND RADIATION RESISTANCE IN POCKET MICE (HETEROMYIDAE: PEROGNATHUS). Gambino, J. J.; Towner, J. W. (Northrop Space Labs., Hawthorne, Calif.). 1966. Contract NASw-812. 10p. (NASA-CR-69454; CONF-660614-12). CFSTI.

From 3rd International Congress on Radiation Research, Cortina, Italy.

Pocket mice (Perognathus longimembris), subjected to 1000 and 1500 rad whole body ^{60}Co irradiation, were sacrificed in groups of 5 on days 1, 2, 5, 6, 7 post-irradiation. Degenerative changes were noted in the intestinal mucosa within hours after irradiation, but visible damage was confined mainly to intestinal crypts. Villi remained intact throughout the observation period, but showed some reduction in size. Regeneration of mucosal epithelium was prompt, restoring villi to normal by the 7th day even after 1500 rad. Tritiated thymidine studies indicate that intestinal epithelium cells of pocket mice have a villus transit time of 5.7 days. This slow rate of villus attrition probably enhances post-irradiation survival, accounting, in part, for the high $LD_{50/30}$ (1500 R) reported for this species. (STAR)

38425 (NYO-3355-31) THE EFFECT OF IONIZING RADIATION ON DEVELOPMENT OF EMBRYONIC MOUSE ORGANS. Final Report. [Borghese, Elio] (Naples Univ. (Italy). Istituto di Anatomia Topografica). Mar. 1968. Contract AT(30-1)-3355. 10p. Dep. CFSTI.

Studies were conducted on the effects of radiation on development of lungs, salivary glands, and kidneys. Effects of x radiation on lung tissue explanted from embryos at the eleventh day of gestation and cultured in vitro were determined. It was found that epithelial growth was enhanced by mesenchyme. X radiation applied in doses from 50 to 400 R inhibited growth. Correlation of lung epithelial growth rate with mitotic rate was studied by means of colchicine treatment. Salivary glands were explanted from embryos at the 13th day of gestation and cultured for seven to nine days; growth was inhibited by x radiation doses of 100 to 500 R. Kidney tissues were explanted at the eleventh day of gestation and studies on development in vitro showed that growth was severely retarded in comparison with normal growth. Studies on ossification in vitro were conducted by explanting cartilaginous anlage of the humerus, radius, and ulna from embryos on the thirteenth day of gestation. (H.L.W.)

38426 (NYO-3698-1) IMMEDIATE STIMULATING PROPERTIES OF X RAYS. Progress Report, May 1, 1967-April 30, 1968. Garcia, John (Massachusetts General Hospital, Boston). Contract AT(30-1)-3698. 27p. Dep. CFSTI.

Studies were conducted on sensory perception of x rays by rats. The problem as to whether the stimulating influence is exerted directly on the olfactory receptors or by way of airborne products is of particular interest. Rats are being trained to discriminate between flickering and steady state exposure to x rays. The effects of x radiation on the frog heart were studied, and it was found that the rate of beating decreased. Experiments with atropine indicated that the radiation caused the release of acetylcholine from synaptic endings of the vagus nerve. In vivo and in vitro preparations of guinea pig intestine (ilium) showed increased tone after the onset of x radiation. Similar changes were seen in uterine preparations. Effects of serum from γ-irradiated rats caused marked increase in tone of the ilium in vitro. Radioinduced aversions to water flavored with hydrochloric acid or quinine were produced in rats. It was found that drinking a low preference fluid during x radiation caused a decrease in preference while drinking the same fluid without exposure caused an increase in preference. A radiomimetic drug, cyclophosphamide, was injected into rats, and the effect was to cause a reduction in consumption of saccharin water. Frog muscle cells were used for measuring changes in membrane conductance of currents across the cell membrane during exposure to beta rays. (H.L.W.)

38427 (ORO-659) SEMIANNUAL PROGRESS REPORT, JANUARY 1-JUNE 30, 1967. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Jan. 1968. Contract AT(40-1)-Gen-242. 108p. Dep. CFSTI.

GAMMA RADIATION — effects on development of fetuses of cattle, sheep, and swine following whole-body exposure of pregnant mother; effects on growth of rats following exposure as fetuses; effects on fertility and mortality of cattle, whole-body latent; effects on survival of burros, effects of dose fractionation on whole-body; effects on survival of burros, combined effects of neutrons on whole-body; effects on survival of swine, combined effects of neutrons on whole-body; effects on work performance of Shetland ponies, whole-body; effects on strontium-89 metabolism in cattle, sheep, and swine; effects on calcium-45 metabolism in cattle, sheep, and swine, whole-body; effects on plants of barley, cotton, oats, soybeans, and wheat, effects of seed exposure on

CESIUM-134 — uptake by fetuses of rabbits following injection into mother, effects of gestation stage on

IODINE-131 — uptake by fetuses of rabbits and swine following administration to mother, effects of gestation stage and thyroid development on; beta emission by, effects of, on thyroid glands of cattle in relation to iodine metabolism and milk production; gamma emission by, effects of, on thyroid glands of cattle in relation to iodine metabolism and milk production; beta emission by, effects of, on thyroid glands of chickens in relation to iodine metabolism and reproductive capacity; gamma emission by, effects of, on thyroid glands in chicken in relation to iodine metabolism and reproductive capacity

CALCIUM-45 — radiation effects on metabolism of, in cattle, sheep, and swine, whole-body γ; uptake by mucosa of intestine of quail following perfusion; uptake by small intestine of chickens following perfusion, effects of content of calcium and strontium in perfusate on

STRONTIUM-85 — uptake by fetuses of rabbits following injection into mother, effects of gestation stage on; uptake by small intestine of chickens following perfusion, effects of content of calcium and strontium in perfusate on

NEUTRONS, PROMPT — effects on survival of burros, combined effects of γ rays on whole-body; effects on survival of swine, combined effects of γ rays on whole-body

IODINE-125 — uptake by fetuses of rabbits and swine following administration to mother, effects of gestation stage and thyroid development on

OVARIES — development in fetuses and infants of swine

RADIUM — alpha emission by, effects of, on sheep following injection, latent pathological; gamma emission by, effects of, on sheep following injection, latent pathological

STRONTIUM-90 — beta emission by, effects of, on sheep following injection, latent pathological

STRONTIUM-89 — radiation effects on metabolism of, in cattle, sheep, and swine, whole-body γ

MOLYBDENUM-99 — metabolism in cattle, sheep, and swine, effects of diet, method of administration, and species on

NEUTRONS, FAST — effects on hair color and organ weight of swine, unilateral

ZINC-65 — metabolism in swine, effects of content of calcium and zinc in diet on

FISSION PRODUCTS — diffusion in soils, reaction mechanisms for

NEUTRONS, FISSION — effects on plants of barley, cotton, oats, soybeans, and wheat, effects of seed exposure on (C.H.)

38428 (UCRL-18140, pp 197-212) THE ESTABLISHMENT AND EFFECTS OF A ^{226}Ra BODY BURDEN. Gabay, Jack J. (New York State Dept. of Health, Albany); Sax, N. Irving; Brown, Charles D.

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

A 45-year-old married man with three living children and with a known exposure to ^{226}Ra and ^{210}Pu was studied for the past 15 years to determine the extent of any resulting body burden and its possible effects. The existence of a ^{226}Ra body burden was established

by whole-body counting and expired-breath radon measurements at several different facilities. Possible effects were studied by means of medical examinations, skeletal x rays, clinical blood tests, and analysis of short-term lymphocyte cultures in peripheral blood for assessment of chromosomal damage. (auth)

38429 (UCSF-10-P-2-49) SPECIES DIFFERENCES IN LEUKOCYTE RESTORATION AFTER IRRADIATION. Patt, Harvey M. (California Univ., San Francisco. Lab. of Radiobiology). May 1968. Contract AT(11-1)-Gen-10. 22p. (CONF-680518-1). Dep. CFSTI.

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan.

Evolution of the blood leukocyte response to radiation is known to be dependent upon species and strain as well as upon dose and dose rate. A species dependency applies particularly to the granulocytes, less so to the lymphocytes. Several factors must enter into an analysis of the differential response to radiation within and among species. These pertain to cell radiosensitivity, cell population kinetics, organizational and regulatory features of the system. Although facets of the overall leukocyte response can be understood in terms of these variables, it is not yet possible to make quantitative predictions about the entire spectrum of leukocyte behavior in different species under different conditions of irradiation. This follows from our still rather superficial understanding of normal leukocyte systems and their control. The factors entering into mechanisms of blood depopulation and repopulation cannot be deduced from study of the time course alone. The known complexities provide enough flexibility such that any number of variables at the level of the cell and/or the system could account for strain and species differences. (auth)

38430 (UR-49-876) FRACTIONATION OF DOSE IN RADIATION-INDUCED MALE STERILITY. Casarett, George W.; Eddy, Hubert A. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Mar. 18, 1968. Contract W-7401-eng-49. 8p. (CONF-680410-1). Dep. CFSTI.

From Symposium on Dose Rate in Mammalian Radiation Biology, Oak Ridge, Tenn.

Life-long whole-body x irradiation (1,000 KVP) of male beagles after 22 months of age with daily doses (in 10 minutes) of 0.06 R or 0.12 R caused no deleterious effects on spermatogenesis detectable by means of monthly seminal sperm counts. Daily doses of 0.6 R caused reduction of seminal sperm count, beginning at about 20 weeks of irradiation, becoming less than 6% of normal within a year, and reaching zero after additional periods of one to several years, with persistence of aspermia thereafter. Brief single x-ray exposures of the whole body of beagles with doses of 300 R or 375 R, and brief single x-ray exposures of the testes with doses of 1000 R, 1500 R, or 2000 R, caused marked oligospermia or aspermia to develop within 10 to 25 weeks post-irradiation, but permitted various degrees of recovery. The greater the dose, the more rapid was the development of aspermia, the more delayed was the onset of recovery, the slower was the rate of recovery, and the smaller was the degree of recovery. In contrast, daily x-ray doses (in 10 minutes) of 3 R to a cumulated dose of 375 R caused a greater degree of irreversible depression of sperm production than did the single brief dose of 375 R, and when the cumulated dose was 475 R or greater, 100 percent of the dogs became permanently aspermic. Therefore, this mode of exposure was at least four times as efficient for this effect as the single brief exposure of the testes. (auth)

38431 (UR-49-934) PATTERNS OF RECOVERY FROM LARGE SINGLE-DOSE EXPOSURE TO RADIATION. Casarett, George W. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Apr. 11, 1968. Contract W-7401-eng-49. 18p. (CONF-680518-2). Dep. CFSTI.

From Conference on Comparative Cellular and Species Radiosensitivity in Animals, Kyoto, Japan.

Quantitative data for various mammalian species on patterns of sensitivity or resistance to radiation lethality after previous single radiation exposure are reviewed, compared, and discussed with respect to their meaning in terms of injury, repair, and recovery. Recovery rates, and the details of the patterns or time-courses of recovery vary with species, strain, sex, size of conditioning dose and its rate, criterion level of mortality, parts of body exposed, experimental methods, and perhaps other factors. Although a simple exponential recovery function may be a reasonable fit grosaly to some recovery data during certain parts of the recovery pattern, the fine structure of the recovery curves show significant deviations from this simple function, including cyclic phenomena, evidences of reversals of recovery trends and even increased resistance or over-recovery, and recovery rates and patterns cannot be described generally and adequately by single rate constants. Available data indicate no clearcut relationship between recovery rate and body size, basal metabolic rate, radiation LD_{50}, or natural life span among species. Hypotheses relating responses of cells, tissues and systems to rates and patterns of recovery and residual injury are discussed briefly. (auth)

38432 EXAMINATIONS ON THE INFLUENCE OF A SINGLE WHOLE-BODY IRRADIATION OF THE GUINEA PIG ON SEGMENT-INDEX OF THE NUCLEI OF NEUTROPHILE GRANULOCYTES IN DEPENDENCE ON DOSE AND TIME. zur Horst-Meyer, H.; Petroff, Ch. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 663-74(1967). (In German).

Within the first five days after whole-body x irradiation of guinea pigs the segment-index of the nuclei in neutrophile granulocytes increased, depending on dose. After the fifth day the index decreased as a consequence of the beginning of recovery. The beginning of recovery may be recognized by segment-index rather than by the number of granulocytes, as the number of granulocytes in the peripheral blood is subordinate to a mechanism of release regulation from the intermedullary reserve which the segment-index is not subject to. For this reason, this method of determination in diagnosing hematologic radiation injury is important as a parameter. (auth)

38433 EFFECT OF IRRADIATION AND CHLORAMPHENICOL ON CORNEAL IMMUNE RESPONSE OF RABBITS. Lanzieri, Mario.; Revoltella, Roberto (Univ. of Padua). Amer. J. Ophthalmol., 65: 709-21(May 1968).

Irradiation of the whole-body with elevated sublethal doses (two applications of whole-body γ irradiation of 400 rads each) permitted successful takes of interlamellar corneal transplants in rabbits. Irradiation of the head alone (two applications of γ of 300 rads each), or of the entire eye or the corneoscleral limbus only (plesio-Chaeul therapy for a total of 500 rads), did not provide positive results. Chloramphenicol, which inhibits protein synthesis if administered in high doses (1500 mg/diem), permitted a take of an analogous heterologous transplant only in a certain percentage of cases. The results are discussed particularly in light of the qualitative cellular response to the transplant that was analyzed histologically and by blood testing. (auth)

38434 MORPHOLOGICAL CHANGES OF THE SPLEEN AND LYMPH NODES IN CHRONIC RADIATION SICKNESS CAUSED BY ^{90}Sr. Vlasov, P. A. Med. Radiol., 11: No. 11, 78-80(Nov. 1966). (In Russian).

Morphological changes in the spleen and lymph nodes of rats were observed over a 24-month period following intraperitoneal injection of 0.1 μCi/g of ^{90}Sr administered in a NaCl solution. The results showed early signs of necrosis in the spleen, followed by reduced size of lymph nodes. From the 9th to 23rd month marked degenerative processes and necrotic lesions were observed in the spleen. (R.V.J.)

38435 MEASURE OF NONREPARABLE INJURY TO HEMATOPOIETIC STEM CELLS IN RATS EXPOSED REPEATEDLY TO X RAYS. Baum, S. J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res., 32: 651-7(1967).

Erythropoiesis essentially ceases in the polycythemic rat. It has been established that stimulation by exogenous erythropoietin is a measure of the capacity of the stem cell pool in this animal to release cells for erythrocyte proliferation. Polycythemic rats that had been previously exposed to 300 R of x rays, and for which the rate of erythrocyte stem cell recovery had been established, were given a 3-month rest period and then exposed for a second time in one experiment and for a second and third time in another. The results clearly indicated a significant decrease in the rate of erythropoietic recovery after each repeated exposure during the rapid repair phase from day 1 to day 6 postirradiation. Since this is the time when, owing to the sustained injury, the red cell renewal system is stimulated to its fullest, a reduction in the existing cell population capable of responding to erythropoietin would be noticed and would be an indicator of residual injury. It appears, therefore, that the present experiment further substantiates the hypothesis established in an earlier report that residual injury induced in the erythropoietin system by sublethal ionizing radiation was caused by a reduction in the total stem cell space. (auth)

38436 EXPERIMENTAL DYSENTERY IN IRRADIATED MONKEYS. Yakovleva, L. A.; Dzhikidze, E. K. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Med. Radiol., 11: No. 11, 80-1(Nov. 1966). (In Russian).

The development of dysentery and colitis in young monkeys (Macaca rhesus) following exposure to doses of 150 or 300 R x radiation was studied. Microscopic examination of the intestine confirmed the presence of colitis in animals that died from acute radiation sickness. A relation between colitis and the subsequent development of spontaneous dysentery was observed. (R.V.J.)

38437 QUANTITATIVE CHARACTERISTIC OF CELL DAMAGE OF VARIOUS CENTERS OF BONE MARROW IN THE EARLY PERIOD AFTER IRRADIATION. Beloussova, O. I.; Gruzdev, G. P.; Fedotova, M. I. Radiobiol.-Radiother., 8: 615-20(1967). (In German).

The quantitative changes of bone marrow cells in the early period (5 to 7 hours) after whole-body x irradiation with doses of 25 to 675 R were examined in 263 rats. For irradiation with doses up to 100 R the decrease of cell count of bone marrow was caused by the reduction in the mature cells of the myeloid series. With doses of 150 R and above the decrease of bone marrow cells was mainly caused by the death of lymphocytes and erythrocytes. (auth)

38438 RESULTS OF RADIOBIOLOGICAL–RADIOHEMATOLOGICAL EXAMINATIONS OF THE PIG. Morczek, A.; Schmidt, W.; Schaefer, R.; Buerger, M. (Medizinische Akademie, Ger.). Radiobiol.-Radiother., 8: 641-53(1967). (In German).

Mature young swine were x irradiated in four groups, at doses of 300 R, 400 R, 500 R, and 600 R. The course of the radiation syndrome, survival rate, and radiation-induced changes of hematopoiesis depending on dose was determined. The pathomorphological picture of radiation sickness for this animal species was characterized by an extensive generalized hemorrhagic diathesis and by an atrophy of the lymphatic tissue in lymph nodes, spleen, and tonsils. Swine were considered to be good comparative possibilities to the human for radiobiological experiments. (auth) (TSS)

38439 REPARATION OF RADIATION INJURIES IN RADIOBIOLOGICAL CLINIC. Domshlak, M. P.; Grigor'ev, Yu. G.; Darenskaya, N. G.; Raevskaya, S. A.; Akoev, I. G. Med. Radiol., 11: No. 11, 36-41(Nov. 1966). (In Russian).

Observations of the reaction in 97 persons to partial body x irradiation are presented. Single doses were 25 R with total doses of 300 R per course of treatment. The period of semirestoration of clinical manifestations of the general reaction in the hematopoietic system decreased with increase of the total irradiation dose. (auth)

38440 RADIATION LEUKEMIA. Bogoyavlenskaya, M. P.; Malanina, V. N. Med. Radiol., 11: No. 11, 43-9(Nov. 1966). (In Russian).

Studies on 22 patients with leukemia that developed after radiation exposure are reported. One group comprised ten patients subjected to x radiotherapy for nonhematological diseases. The other group consisted of occupationally exposed medical personnel. In the majority of cases of leukemia, signs of radiation sickness had been observed. Among the forms of leukemia there was a prevalence of reticulosis and hemocytoblastosis. In the group of patients subjected to x ray therapy there were acute and subacute variants of the disease, whereas in the group of radiologists, chronic forms, commonly lymphocytic leukemia were observed. The differences in the origin and course of the leukemic process in the two groups were due to the diverse levels of radiation and the initial state of patients before contact with the radiation sources. (auth)

38441 ON THE TREATMENT OF X-RAY DERMATITIS. Valkov, V. S. (Geschwulstforschungsinstitut, Sofia). Radiobiol.-Radiother., 8: 553-6(1967). (In German).

The development of superficial radiation injuries is discussed. It is postulated that the trophic disturbance depended on the combined character of radiation injuries and the connected inflammatory processes. Histories of 36 patients with x-ray ulcer who underwent iontophoresis were analyzed; 30 patients were cured, 25 of whom were well five years after treatment. It was concluded that iontophoresis severed pathological nerve communication normalized the trophic function of the CNS by suppressing the degenerative processes and stimulating the regenerative processes, therefore x-ray ulcers were cured in a relatively short time. (auth)

38442 THE CYTOLOGICAL PICTURE OF SKIN INFLAMMATORY REACTIONS IN PERSONS EXPOSED TO THE CHRONIC ACTION OF IONIZING RADIATION. Gribova, I. A. Med. Radiol., 11: No. 11, 82-3(Nov. 1966). (In Russian).

Cytological studies were made on radioinduced inflammations of the skin. Skin reactions of a group of 101 persons exposed to maximum permissible doses of x radiation during a 6-yr period were compared with those of another group exposed during a 9-yr period to doses of x radiation that exceeded maximum permissible doses by four to five times. The first group showed reduction in the number of macrophages with no changes in the number of neutrophils in skin samples. The second group showed a reduction in the number of neutrophils in skin samples that was related to neutrophilia in the peripheral blood. (R.V.J.)

38443 RADIATION-INDUCED CHANGES IN THE DISTRIBUTION OF THE ENDOGENIC RADIOACTIVITY BOUND TO VARIOUS SERUMPROTEINS IN PATIENTS TREATED WITH ^{131}I. Bednar, J.; Nemec, J.; Soutorova, M.; Roehling, S. (Forschungsinstitut fuer Endokrinologie, Prague). Nucl.-Med, 7: 73-81 (May 15, 1968). (In German).

Following the administration of therapeutic doses of radioactive iodine (^{131}I) the distribution of the radioactivity bound to various serum proteins was observed by means of paper electrophoresis in TRIS-EDTA-boric acid buffer at pH 8.9. Changes occurred mainly in the inter-alpha and the beta globulin fractions and were related to the radiation dose absorbed by the thyroid. The observed effects are discussed in detail. (auth)

38444 INVESTIGATION OF THE ABSORPTION OF VAPOROUS RADIOIODINE COMPOUNDS BY THE HUMAN SKIN. Gorodinskii, S. M.; Eskova-Soskovets, L. S.; Rokhlin, M. I.; Sokolov, Yu. Ya.; Turkin, A. D.; Fishevskaya, E. A.; Cherednichenko, V. A.; Shatskii, S. N.; Shorokhov, A. I. Med. Radiol., 12: No. 8, 57-60 (Apr. 1967). (In Russian).

Techniques for investigating the penetration of volatile radioiodine compounds through intact human skin were developed. Experiments were conducted to determine resorption of ^{131}I by human skin during a 4 hr exposure. Quantitative ratios between ^{131}I resorbed through the skin and its content in the air were established. These studies are useful for determining maximum permissible values of ^{131}I that could penetrate an open wound. (H.L.W.)

38445 POSTTHERAPEUTIC MYXEDEMA: RELATIVE OCCURRENCE AFTER TREATMENT OF HYPERTHYROIDISM BY RADIOACTIVE IODINE (^{131}I) OR SUBTOTAL THYROIDECTOMY. Bronsky, David; Klamko, Rosario T.; Waldstein, Sheldon W. (Cook County Hospital, Chicago). Arch. Intern. Med., 121: 133-17(Feb. 1968).

The occurrence of myxedema as a complication of radiation treatment of hyperthyroidism was reported. This report presented experience with the myxedema which followed the treatment of hyperthyroidism, discussed the factors which may influence the appearance of postirradiation myxedema, and stressed the need for properly controlled investigations in this area. The general policy for therapy of hyperthyroidism with ^{131}I was to administer an initial dose of 5 mCi regardless of size or nodularity of the gland or its uptake of ^{131}I. If hyperthyroidism persisted or recurred, ^{131}I was readministered at intervals of not less than three months. The interval from treatment of hyperthyroidism to diagnosis of myxedema was determined for 53 patients after subtotal thyroidectomy and 39 patients with myxedema following treatment with ^{131}I between 1950 and 1965. The existence of a cumulative incidence of myxedema after treatment of hyperthyroidism by subtotal thyroidectomy as well as by ^{131}I was confirmed. Accrual rates which were reported to be lower following surgery were explained by differences in patient selection and were not necessarily due to inherent differences in the effects of these forms of treatment. Requirements for valid statistical analysis of the absolute and relative incidence of posttherapeutic myxedema have not been met in this or other published studies. Until these requirements are met, definitive statements about the magnitude of the risk of myxedema following treatment of hyperthyroidism cannot be made. (BBB)

38446 LETHAL EFFECT DUE TO THE ACTION OF RADIATION UPON THE BONE-MARROW CELLS IN DIFFERENT PHASES OF THE CELLULAR CYCLE. Aleksandrov, I. D. (Inst. of Biological Physics, Moscow). Med. Radiol., 11: No. 11, 50-6(Nov. 1966). (In Russian).

Experiments were made on mice exposed to x rays in a dose of 50 R to study degeneration of bone marrow cells over a period of time corresponding to the duration of the first post-radiation cellular cycle of immature myelo- and erythropoietic elements. The resultant time-effect degeneration curve, within the range of the greatest probability of the difference as compared with controls, conforms to the duration of the cellular cycle, while its individual constituents correspond to different phases of the nuclear elements in the erythropoiesis cycle, thus characterizing varying radiosensitivity of cells in the cycle: high in the period of the DNA synthesis, and lower in the remaining periods of the interphase. The destruction of cells, affected during different phases of the cycle, did not occur directly after irradiation, but at the time marking the passage of these cells into the premeiotic period of the interphase. Preliminary protection of the animals by means of 5-metoxytrytamine did not influence the radiosensitivity of the nuclei-containing erythropoietic cells, characteristics of different phases of the cycle, nor destruction of the cells in the preprophase. (auth)

38447 IMPORTANCE OF REPAIR SYSTEMS FOR THE RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIATION OF

DIFFERING QUALITY: A TWO-SYSTEM THEORY. Fritz-Niggli, Hedi (Univ., Zurich). Strahlentherapie, 135: 202-12 (Feb. 1968). (In German).

The severity of radiolesions was determined by the capacity of recovery. Recovery-systems could be certain enzymes. They were regulated by the energy balance in the cell mostly localized in the mitochondria. The biological objects and the radiation reactions could be divided into a membrane-repair-dependent and a membrane-repair-independent system. A close relationship between repair-systems and radiosensitivity was postulated, where sensitive cells had no repair system or a vulnerable system (mitochondria during transformation). The acceptance of the fact that high LET (Linear Energy Transfer)-radiation apart from other radiolesions, also damaged the membrane-dependent repair-system, explained the so-called irreversible effect of the high LET radiation. For radiations with a low LET, even small differences in LET would be discernible in the membrane-dependent systems. The different effect of high energy electrons and photons of the same energy could be explained by the lower contribution of the alpha-component of electrons. The partly selective action of electrons on tumors could be explained as a selective sparing of the membrane-dependent repair systems. (auth)

38448 PROBLEMS OF THE CLINICS AND THERAPY OF HEMANGIOMATA IN CHILDHOOD. PART III. LATE SOMATIC CHANGES AFTER HEMANGIOMATA IRRADIATION IN CHILDHOOD. Bek, Vaclav; Kolar, Jaromir; Maresova, Jaroslava; Schwank, Richard; Vrabec, Radko (Charles Univ., Prague). Strahlentherapie, 135: 156-65(Feb. 1968). (In German).

Normal tissue radiation damage is an important factor in the treatment of hemangiomata in children. Radioinduced somatic changes in a group of 91 patients with teleangiectatic nevi (after irradiation within the boundary ray range) and another group of 760 hemangiomata (after short source skin distance x irradiation) were investigated. Different radiation damages were found in the skin, the eye lens, the breasts of young girls, in bones, and in the muscles. The possibility of a cancerogenic effect upon the thyroid gland was pointed out and five radioinduced cartilagenous exostoses were mentioned. Due to these side effects, a critical point of view toward the irradiation of hemangiomata of children was expressed and several limits in its use were pointed out. (auth)

38449 CYCLIC VARIATION IN THE RADIATION SENSITIVITY OF RATS. Hellwig, Gerhard; Rosenkranz, Juergen (Univ., Hamburg). Strahlentherapie, 135: 220-2(Feb. 1968). (In German).

Female Wistar rats (180) were irradiated (800 R) at different times of the day. A statistically significant effect ($P < 1\%_{00}$) was observed relating the time of day at which the irradiation was done with the time of death. The difference in the mortality rate (20% survivors when irradiated at 2 p.m., 7% survivors when irradiated at 2 a.m. and 10 p.m.) could not be confirmed statistically. (auth)

38450 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. VI. DISCUSSION. Caveness, William F. (Columbia Univ., New York). Brain Res., 7: 110-15(Jan. 1968).

Comments on experimental design and a summary of functional and structural changes following exposure of portions of monkey cerebral cortex to 3500-rad x irradiation were presented. The evoked responses of the irradiated visual cortex to photic stimulation consisted of a variable decrease in amplitude of the response from the irradiated as compared with those from the nonirradiated side. This effect followed a biphasic course. The first phase began soon after irradiation, reached its greatest expression from six to 12 weeks, then receded with little difference between the two sides for 18 to 22 weeks. Then began the second phase with an even greater relative depression that continued until the animals were sacrified. Both sides showed some decrease in amplitude, greater in the irradiated than nonirradiated side. At 72 hr, routine neuropathology studies revealed no macroscopic or microscopic changes but electron microscopy revealed ultrastructural changes, more prominent on the irradiated side. These consisted of modifications of the nuclear membranes, glycogen granules in the light processes of astrocytes, and lysosomes in blood vessel walls. At one week, there were no macroscopic or microscopic changes of significance, other than minimal reactions in the irradiated cortex, but electron microscopy revealed glycogen granules, lysosome reactivity, and occasional alteration of nuclear membranes, and greater variation in vesicles on the irradiated side. At 12 weeks, routine microscopic examination revealed moderate astrocytic hyperplasia and microglial hypertrophy and hyperplasia in the irradiated cortex. Electron microscopy showed glycogen granules, astrocytic proliferation, enlargement of Golgi canaliculi, lipid material undergoing phagocytosis, and variation in size and number of vesicles in presynaptic terminals. At 20 weeks, all animals showed depilation, with scalp changes, and routine microscopy revealed inflammatory reactions in the leptomeninges. The parenchyma showed inflammatory and glial reactions with moderate vascular proliferation. Routine microscopy revealed areas of necrosis in grey and white matter, at times confluent. Cellular and myelin losses were severe. All glial elements showed proliferative and degenerative changes. Vascular reactions included thromboses and telangiectasia. The first phase of reduction in EEG amplitude, at four to 12 weeks, was probably the result of a reduction in basilar dendritic ramifications and the observed alteration in dendritic spines. The second phase, 28 to 44 weeks, was probably the result of further alteration and loss in basilar dendritic ramifications plus a loss in apical ramifications, and a loss in cell bodies. The early and late depression on the nonirradiated side probably represented a transcallosal influence from the irradiated side, and the reflection of the delta and theta activity from the nonirradiated side was probably a remote influence from the reaction of injury arising from the irradiated area. The early appearance and alteration in lysosomes could indicate an isoimmune reaction that contributed to the subsequent destruction of neural tissue. No vascular alterations were seen until well after significant neuronal impairment. (BBB)

38451 INITIAL SIGNS AND CLASSIFICATION OF RADIATION CATARACT. Lutsker, L. S. (Moscow Research Inst. of Roentgen-Radiology). Med. Radiol., 12: No. 8, 39-42(Apr. 1967). (In Russian).

The initial signs of radiation injury of the crystalline lens and a classification that contains five stages in the development of radiation cataract are presented. Early signs of radiation cataract may be revealed only in biomicroscopic investigation and are manifested by the accumulation of very small grey spots in the posterior pole under the capsule, forming a ring or semi-ring, polychronic iridescent in reflected light. In order to confirm the diagnosis of radiation cataract it is necessary to take into consideration the past history of the patient, the term of irradiation and value of absorbed dose by the crystalline lens. (auth)

38452 ULTRASTRUCTURE OF SOME TISSUES IN PROTRACTED ^{54}Mn RADIATION EFFECT. Gulyaev, V. A.; Lysogorov, N. V.; Filatov, P. P. (Inst. of Medical Radiology, Moscow). Med. Radiol., 12: No. 8, 47-52(Apr. 1967). (In Russian).

Rats were treated with 11.5 μCi daily doses of ^{54}Mn for a period of nine months. The total dose comprised 4.6 rad. One year after the experiment, electron microscope studies were made on thrombocytes of the peripheral blood, liver cells, and bone marrow. Thrombocytes were characterized by loss of alpha granules and formation of degenerative vacuoles. Swelling of mitochondria was noted in Marenheim's cells of the liver. Degenerative changes in the mitochondria of hemocytoblasts and lymphocytes in the bone marrow were noted. The number of plasmatic cells was increased. (H. L. W.)

38453 MORTALITY RATES IN A BRAZILIAN AREA OF HIGH BACKGROUND RADIATION. PRELIMINARY ANALYSIS BASED ON OFFICIAL RECORDS. Freire-Maia, Ademar; Freire-Maia, Dertia V. (Faculdade de Ciencias Medicas e Biologicas, Botucatu, Spain). An. Acad. Brasil. Cienc., 39: 467-9(Dec. 31, 1967).

Official data on mortality rates, sex ratio, and incidences of congenital blindness and deaf-mutism, in Brazilian areas with high and normal background radiation are presented. The meaning of the differences detected is discussed. The desirability of more data is emphasized. A full report, including the analysis of new data, is presently under preparation. (auth)

38454 APPARENT ABSENCE OF RECOVERY IN ENDOGENOUS COLONY-FORMING CELLS AFTER IRRADIATION UNDER HYPOXIC CONDITIONS. Phillips, Theodore L.; Hanks, Gerald E. (Univ. of California, San Francisco. Naval Radiological Defense Lab., San Francisco). Radiat. Res., 33: 517-32(1968). (UCSF-10P2-31).

Groups of LAF_1 adult mice were subjected to both graded and divided doses of radiations under hypoxic conditions and in air. The endogenous spleen colony-forming unit technique was used to measure the effect of the irradiation on survival of the colony-forming cells. Dose-response curves indicated a D_{37} of 83 rads in air and 201 rads under hypoxic conditions, yielding an oxygen enhancement ratio of 2.4. Survival ratios were obtained for times between three and 36 hours using two doses of 260 rads each in air and 520 rads each under hypoxic conditions. The survival ratio in animals irradiated in air shows peaks at nine and at 27 hours. The survival ratio in animals irradiated under hypoxic

conditions was not increased at any time and fell after 4.5 hours following the initial dose. The results suggested that in the mouse colony-forming cell the degree of early cellular repair is markedly decreased when radiation injury occurs under conditions of hypoxia. (auth)

38455 PROTECTIVE ACTION OF TRANSPLANTS OF SPLENIC CELLS OF IMMUNE AND INTACT DONORS IN IRRADIATED MICE. Panteleev, E. I.; Pozdnyakov, A. L. Med. Radiol., 12: No. 8, 52-7(Apr. 1967). (In Russian).

Following γ irradiation at doses of 750 R, inbred CBA mice were given transplants of isologous spleen cells from intact donors and donors immunized with sheep erythrocytes. Immunization caused an increase in the total quantity of nucleated cells as well as in the relative number of plasmablasts and plasmacytes in the donor spleen. Statistically significant protection of lethally irradiated recipients was obtained by spleen cells of intact donors. The therapeutic efficacy of immunized donor spleen cells was as great as that of the intact donors. (H.L.W.)

38456 BASIS FOR THE LIMIT ON WHOLE-BODY EXPOSURE. EXPERIENCE OF RADIOLOGISTS. Warren, S. Health Phys., 12: 737-41(June 1966).

Current data on life spans of U.S. radiologists for the period 1938 to 1965 reveal that their mean age at death has lengthened, until no life shortening is apparent after 1960 when compared with U.S. white males over 25 years of age. The mean age at death of radiologists increased from 58.9 years in the 1940's to 69.5 years since 1960. This effect is attributed to the fact that radiologists' exposures have been reduced in accordance with the maximum permissible dose guides which have been progressively reduced in the U.S.A. until the present levels were reached in 1949. The incidence of death from leukemia among radiologists has decreased in recent years and currently is about 5 times that of U.S. males. This effect is felt to be due to exposures well in the past. (Occup. Safety and Health Abstr.)

38457 SILVER UPTAKE AND DISPOSITION IN BRAINS OF CHRONIC GAMMA-IRRADIATED AND NON-IRRADIATED ALBINO RATS: A STUDY BY ELECTRON MICROSCOPY AND NEUTRON ACTIVATION ANALYSIS. Scott, Walter Louis Jr. College Station, Tex., Texas A and M Univ., 1965. 124p.

Thesis.

Albino rats that received silver nitrate solutions and were maintained for extended periods of time in varying environments of low-level, whole-body, γ irradiation (20, 10, 5, and 2 R per day) and nonirradiated control animals did not differ appreciably as to the concentration or the deposition of Ag in brain tissues as revealed by neutron activation analysis and electron microscopy. The 0.66 MeV photopeak of ^{110}Ag (24.2 sec half-life) was used in the determination of microgram amounts of Ag in the brains of the animals. The results indicated that the integrity of the blood-brain barrier remained intact under the experimental conditions employed. The deposition of Ag precipitate, as disclosed by electron microscopy, was the same in both irradiated and non-irradiated animals. (TSS) (Disser. Abstr.)

38458 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. V. ULTRASTRUCTURAL FINDINGS. Roizin, Leon (New York State Psychiatric Inst., N. Y.); Schade, J. P. Brain Res., 7: 87-109(Jan. 1968).

To provide objective information concerning the degree of the ultrastructural and synaptic variations between the irradiated (3500 rad) and nonirradiated sides of monkey cerebral cortex, qualitative electron microscope studies were supplemented by quantitative evaluations. Electron microscopy at 72 hr revealed ultrastructural changes, more prominent on the irradiated side. These consisted of modifications of the nuclear membranes, glycogen granules in the light processes of astrocytes, and lysosomes in blood vessel walls. Electron microscopy at one week revealed glycogen granules, lysosome reactivity and occasional alteration of nuclear membranes, and greater variation in vesicles on the irradiated side. At four weeks, in addition to the changes previously described, there were multivesicular bodies in presynaptic terminals and evidence of astrocytic reaction in the irradiated cortex. Quantitative evaluation of electron micrographs showed a significant reduction in volume of neutrons and an increase in glial elements. Also demonstrated was an increase in blood vessels in one animal. At 20 weeks were seen concentrations of glycogen granules in various brain cellular structures, lysosomes undergoing metamorphosis, mitochondrial pleomorphism, alterations in the myelin sheath, variation in number, shape, and size of presynaptic terminals, and, in some areas, separation of synaptic terminals by glial processes. Glycogen granules were prominent at 28 weeks and there were variations in number and size of synaptic vesicles. The neuropile was dominated by glial processes. There were myelin debris and enlargement of the Golgi vacuoles and cysternae of the rough endoplasmic reticulum in the cytoplasm. Fine structures of synapses underwent disintegration in areas of necrosis. Some axons appeared to be undergoing remyelinization at 44 weeks, and vascular walls appeared thickened and surrounded by glial processes. There were variable concentrations of lysosomes undergoing metamorphosis. Quantitative measurements revealed a decrease in volume of neurons and an increase in volume of glial elements. (BBB)

38459 EFFECT OF ENDOGENOUS ERYTHROPOIETIN ON REPLICATING HEMOPOIETIC STEM CELLS. DeGowin, Richard L.; Johnson, Shirley (Univ. of Chicago, Argonne Cancer Research Hospital, Chicago). Proc. Soc. Exp. Biol. Med., 126: 442-6(Nov. 1967).

Autorepopulation studies using a radiobiological method provide evidence that endogenous hemopoietic stem cell proliferation in the shielded mouse occurred during the first 5 days after x irradiation. Exposure to hypoxia, sufficient to produce elevated levels of endogenous erythropoietin, failed to induce erythroid differentiation during the early proliferative phase of marrow repopulation. The data support the concept that the replication of stem cells, per se, renders them refractory to the induction of erythroid differentiation by erythropoietin. (auth)

38460 POSTNATAL EFFECTS OF CONTINUOUS GAMMA IRRADIATION DELIVERED ON SPECIFIC GESTATIONAL DAYS IN THE ALBINO RAT. Ricks, Robert Clinton. College Station, Tex., Texas A and M Univ., 1967. 74p.

Thesis.

Seventy-five mature pregnant female rats of the Wistar strain were irradiated with 300 R low intensity γ radiation delivered at 50 R per 20-hr-day for six successive day intervals during the gestational period. Mortality of the offspring in each group was followed up to 65 days of postnatal life, at which time one-half of both sexes from each group was necropsied. The total dose of 300 R increased the pre- and postnatal mortality of the irradiated animals as compared to the controls. Gross abnormalities in the irradiated offspring were relatively low in frequency and consisted of hydrocephaly, anopthalmia, knobby tail, epilation, and a urogenital disorder. The anopthalmic individuals exhibited no residual eye tissue. One-half of the remaining animals was necropsied at 110 days of postnatal life and the remaining at 140 days of postnatal life. At necropsy body and organ weights were obtained. Testes, seminal vesicles, and ventral prostates were taken from the males while ovaries and uteri were taken from the females for histological examination. The body weights of treatment animals were depressed in general when compared to the controls. Complete sterility was noted in males irradiated during the periods between 12.5 to 18.5 prenatal days, 18.5 pre- to 2.5 postnatal days, and in females irradiated during prenatal days 6.5 to 12.5 and 12.5 to 18.5. Male sex accessory organs were depressed in all irradiated animals. Histological examination showed the severely damaged testes contained seminiferous tubules with very few germinal cells; the primary cellular component was the Sertoli cell. Interstitial cells were numerous and there was apparently little damage to the endocrine function of the irradiated testes. Females with severe gonadal damage (sterility) possessed ovaries consisting of stroma and medullary cords. No oocytes were present in severely damaged ovaries, and the depression of endocrine function was reflected by uterine weights. (Diss. Abstr.) (TSS)

38461 THE ROLE OF THE SPLEEN IN HEMOPOIESIS AND ITS RELATIONSHIP TO POST-IRRADIATION PHENOMENA. DeBiase, Paul Louis. Jamaica, N. Y., St. John's Univ., 1966. 157p.

Thesis.

The role of the spleen as a regulator of blood cell production and/or release, was investigated. X irradiation was utilized to evaluate splenic participation in post-radiation recovery of hemopoietic tissues in rats following initial suppression by high doses of radiation. Splenectomy was utilized to investigate the nature of the protection ascribed to this organ and further assess its regulatory influence on the regenerative capacity of demedullated femurs of rats. To investigate the potentiality of spleen cells as precursors or stem cells, suspensions of splenic cells were introduced directly into the femur of splenectomized and intact irradiated rats. Supporting the concept that a humoral bone marrow inhibitor is elaborated by the spleen is the evidence obtained from the splenectomy-demedullation and irradiation studies. Higher levels of peripheral blood reticulocytes and granulocytes were evident in animals which had been splenectomized following demedullation of a single femur. Marrow analyses revealed that significantly higher numbers of nucleated erythrocytes and blast cell forms accompanied the peripheral elevations. Rehabilitation of the bone marrow population, reflected by significantly higher total nucleated cell popula-

tions, was more evident in animals which had been splenectomized prior to exposure to 600 R whole-body x radiation. Myelograms revealed that erythroid and myeloid precursor cells appeared earlier and in higher numbers than in the non-splenectomized irradiated animals. Moreover, the peripheral blood of the splenectomized rats exposed to 630 R exhibited a reticulocytosis and leukocytosis earlier than the intact irradiated controls. The presence of nucleated erythroid and blast cells also characterized the peripheral blood of the splenectomized group. It appears that the spleen does exhibit a regulatory function over the maturation and/or rate of emission of cells from the bone marrow. Whether this is the result of an inhibitory hormone normally elaborated by the spleen or some other organ in concert with the spleen remains unclear. That splenic cell suspensions contain blood cell precursors or stem cells was substantiated by the protective effects elicited by the injection of these cells into an irradiated animal's bone marrow cavity. (Diss. Abstr.) (TSS)

38462 INVESTIGATION OF THE BEHAVIOR OF CORPUSCULAR BLOOD CONSTITUENTS IN PERSONS EXPOSED TO MICROWAVES. Baranski, Stanislaw; Czerski, Przemyslaw. Lek. Wojsk., No. 10, 903-9(1966). (In Polish).

The morphologic blood composition of a large number of people was studied. Persons examined were divided into the Exploitation (E) group, least exposed to microwave irradiation; the Special Exploitation (ES) group exposed to higher irradiation levels; and the R worker group, exposed to high irradiation levels involved with repairing or manufacturing microwave generator equipment. Hemoglobin, red and white blood cell count, and differential analysis were done routinely. Recticulocyte and platelet counts were done for selected groups, and bone marrow punctures were performed on 19 persons. Each of the three main groups was divided into four subgroups according to length of employment (from 1 to 10 years). The number of erythrocytes was lower than 3,500,000/mm^3 in sporadic cases and there were no figures exceeding normal levels. Reticulocytes were most numerous in the E group, and reticulocytosis was most frequent in the five-to-ten year employment group. White blood corpuscle counts were normal regardless of group. Sporadic cases of neutrophilic leukocytosis lasting more than five years were encountered, but even multiple testing did not disclose their causes. Cases of lymphocytopenia occurred rarely; their frequency was independent of group. The investigation led to the following conclusions, also reflected in statistical tabulations of granulocytosis, eosinophilia, monocytosis, lymphocytosis, and granulocytopenia occurrences: A small drop in the amount of erythrocytes takes place in all people exposed to microwaves; occurrence is related to the length of employment and degree of exposure. Various leukocyte shifts occur in the first year of employment. Later, normalization occurs and this symptom does not appear in groups having worked for one to five years. A tendency toward lymphocytosis with accompanying eosinophilia is apparent in persons having worked more than five years under conditions of low and medium microwave exposure. Three groups of leukocyte changes occur in persons exposed to substantial irradiation for more than five years. Most frequent are absolute and relative lymphocytosis accompanied by eosinophilia and monocytosis, or relative lymphocytosis. Next in order is absolute lymphocytosis with monocytosis. Neutrophilic leukocytosis comes last. About 50% of persons exposed to microwaves show a moderate drop in platelet number. (ATD)

38463 ON THE EFFECT OF LOW DOSES OF IONIZING RADIATIONS OF DIFFERENT QUALITY ON THE TIBIA OF WISTAR RATS. Prehn, E. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 763-6(1967). (In German).

Investigations of the RBE in the dose interval of 1000 to 2000 R of ultrahard quantum radiation, high-energy electron radiation, and conventional x radiation tested by the delay of growth of the tibia of Wistar rats, Degner found no qualitative differences in the course of reaction. In order to elucidate an indicated deviation for the lowest dose used, analogous experiments in the adjacent lower dose range down to 200 R were performed. These experiments also revealed a similar course of the reaction curves thus confirming that there is no qualitative difference for the tested radiation qualities in the test object used. (auth)

38464 BEHAVIORAL AND STRUCTURAL CHANGES FOLLOWING X-IRRADIATION OF THE FOREBRAIN IN THE RAT. Ingersoll, Everett H.; Carsten, Arland L.; Brownson, Robert H. (Medical Coll. of Virginia, Richmond. Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med., 125: 382-5(June 1967).

The effects of doses of 2,500 or 5,000 RADs x radiation directed to the entire cerebrum on behavior and brain structure were investigated in 90-day-old rats. Results indicated a retardation in the acquisition of an alternating pattern of immediate and delayed reward after the 15th day following exposure to both of the radiation doses. There were no significant differences in the learning curves of the two groups of rats. Histopathological examination revealed, in general, only minor neuropathological differences in the reactions to 2,500 and 5,000 RAD doses. All irradiated brains exhibited moderate alterations in blood vessels and to a limited extent in the underlying white matter with small areas of focal necrosis. Neurons, in general, showed little evidence of alteration. Two brains in the group of 30 irradiated rats showed large necrotic lesions. (C.H.)

38465 EFFECT OF WHOLE BODY IRRADIATION ON COLONY PRODUCTION BY BONE MARROW CELLS IN VITRO. Robinson, W. A.; Bradley, T. R.; Metcalf, D. (Royal Melbourne Hospital, Victoria, Australia. Univ. of Melbourne). Proc. Soc. Exp. Biol. Med., 125: 388-91(June 1967).

The effects of whole-body exposure of mice to doses of x radiation ranging from 50 to 200 R on subsequent colony formation by bone marrow cells cultured on feeder layers of homologous kidney cells in agar were investigated. Results showed that with increased dose of whole-body irradiation there was an exponential decrease in the percentage of cells in the bone marrow capable of in vitro colony formation. This decrease was correlated with a fall in the percentage of small lymphocytes in the bone marrow. The results indicated that the cells that form colonies following transplantation of bone marrow and other hematopoietic tissues in vivo are probably small lymphocytes. (C.H.)

38466 ACUTE EFFECTS OF FAST NEUTRON IRRADIATION ON THE HEMATOPOIETIC ACTIVITY OF SPLENECTOMIZED AND THYMECTOMIZED MICE. COMPARISON WITH X-IRRADIATION AND GAMMA RAY IRRADIATION. Wake, Minoru (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 8, 22-58(1967). (In Japanese).

In order to observe the effects of splenectomy and thymectomy on acute disturbances of hematopoietic activity due to fast neutron irradiation, a group of 40 ten-week-old female splenectomized ddN-JCL(CLEA) mice and another group of 40 ten-week-old female thymectomized ddN-JCL(CLEA) mice were respectively exposed to 320 rads of 14.1 MeV fast-neutrons. During the 30 day observation period following irradiation, blood tests were conducted at given intervals and the animals were sacrificed. In addition to weighing of the lymphatic organs, determination of the DNA content and histological examinations were made of the hematopoietic organs. The results obtained were compared with the results obtained from similar animals exposed to 375 rads of 180 kVp X-rays and 500 rads of ^{60}Co γ-rays that are considered to give the same effects as 320 rads of fast neutron in regard to decrease in nucleated bone marrow cells. In the splenectomized and thymectomized animals the disturbances in hematopoietic activity of bone marrow and in lymphopoietic activity after fast-neutron-irradiation were in equal degrees or as marked as compared with those due to x-irradiation and γ-irradiation, while the recovery was rapid. The characteristic histological findings were noted in the damaged bone marrow due to fast neutron irradiation and regenerating marrow. The disturbances to hematopoietic activity of bone marrow following fast neutron irradiation were markedly reduced by splenectomy and the recovery was accelerated. The damage of lymphopoiesis due to fast neutron irradiation was reduced also, but splenectomy was ineffective in the regeneration of the thymic tissue. The disturbances to lymphopoietic activity after fast neutron irradiation were remarkably intensified owing to thymectomy and the recovery was strongly delayed. The beneficial effects of thymectomy on the damaged bone marrow due to fast neutron irradiation appeared though it was very slight. The stimulating effects of splenectomy on the hematopoietic activity of bone marrow and the inhibitory effects of thymectomy on the lymphopoietic activity were more markedly intensified in animals exposed to fast neutron radiation than in those exposed to x radiation and γ radiation. (auth)

38467 CORRELATION OF THE PROCESSES OF PROLIFERATION AND DETERMINATION IN THE MORPHOGENESIS OF IRIS AND CILIARY BODY IN RATS. Stroeva, O. G. (Severtzov Inst. of Developmental Biology, Moscow). J. Embryol. Exp. Morphol., 18: 268-87(Oct. 1967).

X irradiation and culture of rat eye rudiments in the anterior chamber with and without lens at successive developmental stages (14.5 to 19.5 days of pregnancy) were used to study formation of the neural part of the iris-ciliary body rudiment. At 14.5 and 15.5 days of pregnancy the inner layer of the iris-ciliary body rudiment was still undifferentiated. After lens removal and subsequent eye cultivation in the anterior chamber the pupil margin thickened and transformed into the retina rudiment. After x irradiation (400 R) which caused destruction of more than half of cells in the retina rudiment, a significant increase of the pigmented iris occurred at the expense of the areas of the ciliary body and peripheral retina in the developing eye in situ, as well

as in the eyes cultivated in the anterior chamber. In some cases the whole inner layer of the eye cup transformed into pigmented iris. During the cultivation of x-irradiated eyes without lens the inner eye cup layer retained the structure of the retina rudiment. At these stages proliferating cells of the inner layer of the iris-ciliary body rudiment and of the peripheral area of the retina had the same total duration of the mitotic cycle and of its separate phases, but these zones differed a little in the number of cells which took part in proliferation. After irradiation at 400 R an increase of pigmented area at the expense of the ciliary area was seen in half the specimens. Preservation of the normal ratio of the pigmented part of the inner iris layer and unpigmented ciliary folds after irradiation showed that both the areas of the eye margins and the boundary between them were already determined at 19.5 days of pregnancy. Conclusions were drawn on the time of differentiation of the outer layer of the iris-ciliary body rudiment from its resistance to x irradiation under conditions of separation from the inner layer. (BBB)

38468 BARIUM-INDUCED AUTOMATICITY IN RIGHT VENTRICULAR MUSCLE IN THE DOG. **Reid, J. Alan; Hecht, Hans H. (Univ. of Chicago). Circulation Res., 21: 849-56 (Dec. 1967).**

The effects of Ba^{++} ion on canine ventricular fibers, and the effects of cooling and rapid electrical stimulation of preparations exhibiting Ba-induced automaticity were studied in an attempt to determine the mode of action of Ba ion on cardiac ventricular muscle fibers and to suggest further studies on the effect of bivalent cations on ionic conductance of excitable tissues. Pacemaker activity was induced in trabecular muscle fibers of canine hearts using oxygenated Tyrode solution with added $BaCl_2$. Following exposure to Ba (0.2 to 5 mM) the resting potential decreased toward zero from 10 to 60%, depending on the concentration. Simultaneously, the duration of the action potential increased and early diastolic hyperpolarization appeared with diastolic depolarization characteristic of latent pacemaker activity. In concentrations above 0.75 mM, spontaneous activity appeared with presystolic upsweep at the threshold potential. The changes were reversible when normal Tyrode solution was readministered. Suppression of the induced pacemaker activity occurred on cooling or following imposed rapid stimulation. The changes produced by Ba were consistent with a decrease in the conductance of the membrane for K ion. (BBB)

38469 PHAGOCYTOSIS OF COLLOIDAL PARTICLES OF DIFFERENT SIZES. **Scott, G. B. D. (Medical Coll. of Virginia, Richmond); Williams, H. S.; Marriott, P. M. Brit. J. Exp. Pathol., 48: 411-16 (Aug. 1967).**

Effect of size of colloidal ^{198}Au particles on phagocytosis of the radionuclide was studied in rabbits. Diameters of the ^{198}Au particles were measured by electron microscopy. The blood clearance curves showed a rise in circulating radioactivity, consequent on the injection of the colloid, followed immediately by a rapid fall, the curve becoming flatter as phagocytosis proceeded and background was approached. Intravenous doses of 60 and 100 mg of a preparation of colloidal ^{198}Au with a mean particle diameter of 350 Å produced clearance rates of 0.24 and 0.13 min^{-1}, respectively, but doses of 100 mg were often lethal in rabbits. Colloidal ^{198}Au of smaller particle diameter stabilized in 3.5% gelatin, was chosen and injected in doses of 0.8 mg/100 g of body weight (9.0 to 15.0 mg). This gave clearance slopes of value ranging from 0.8 to 0.15 min^{-1}. Measurement of the diameters of 500 particles of those samples of ^{198}Au showed the peak of the distribution curves at 40 Å. The curves were asymmetrical, smaller numbers of larger particles being present, the largest diameters varying from 110 to 190 Å. When their clearance curves were plotted on semi-logarithmic graph paper, seven of the 10 samples of radioactive colloid gave slopes which were straight lines over the significant part of the curve except close to the background level of radioactivity, where small variations in the estimation of the latter could have a marked effect on the slope. Straight line slopes were produced by all ^{198}Au samples giving low slope values (0.08 to 0.15 min^{-1}) as well as by two of the five giving the higher ones, while those given by the very large doses of the colloid of 350 Å mean particle diameter were of this type. (BBB)

38470 ERYTHROID REGENERATION IN LOCALLY IRRADIATED BONE MARROW OF PLETHORIC RATS. **Hajdukovic, Srdjan; Karanovic, Jovo; Ninkov, Vukosava (Boric Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 135: 59-62 (1968).**

The behavior of erythropoiesis in locally irradiated (800 R) bone marrow of plethoric rats was investigated. Regeneration of the bone marrow begins with production of erythroid cells. The maximum number of the erythroid cells considerably exceeds the normal values although erythropoiesis in plethoric state is almost completely discontinued. The production of erythroid cells is not constant and about the tenth day their number becomes minimal. The irradiation is supposed to induce some local changes that have a favorable effect on erythropoiesis because the plethoric state excludes the regulation mechanism that includes the demand from the peripheral blood. (auth)

38471 EFFECT OF IRRADIATION ON THE SUPPRESSION OF ENZYME IN GUINEA PIGS. **Danysz, Andrzej; Kocmierska-Grodzka, Danuta; Wisniewski, Konstanty; Killar, Marian (Pharmakologisches Institut der Medizinischen Akademie, Bialystok, Poland). Strahlentherapie, 135: 90-3 (1968). (In German).**

Guinea pigs were whole body-irradiated with 400 R, and the activities of MAO (monamine oxidase), transaminase (aspartic and alanino), and catalase were investigated during subsequent radiation sickness (21 days). The decrease of the MAO-activity in liver and brain was confirmed. A biphasic change of the transaminase- and catalase activities was caused by the irradiation. The transaminase activity increased during the first phase of the radiation sickness, followed by a decrease. The catalase activity decreased shortly after irradiation, with an increase nine days after irradiation. (auth)

38472 EFFECT OF RADIATION ON CANINE INTESTINAL ANASTOMOSES. **Crowley, Lawrence G.; Anders, Christopher J.; Nelsen, Thomas; Bagshaw, Malcolm (Stanford Univ., Palo Alto, Calif.). Arch. Surg., 96: 423-8 (Mar. 1968).**

An evaluation was made of the effects of x irradiation, at doses in the clinical range, on postoperative healing of intestinal anastomoses in dogs. Information on the optimal time of radiotherapy before surgery was sought. In anastomotic segments of ileum demonstrating uncomplicated healing there was only one suture line leak with inflation in the control group and none in the irradiated animals. In all other animals the bowel wall when inflated under pressure ruptured at a site away from the suture line. The results indicated that although there was some reduction in the resistance to inflation pressure in irradiated loops of bowel, this was not related to the anastomosis, but rather to the adjacent irradiated bowel wall and was probably due to the direct deleterious effect of radiation on the intestinal wall. The greatest reduction in bursting circular wall tension, and the only one which was statistically significant, was found in the irradiated intact segments of ileum which were obtained at the initial laparotomy one to three days following the completion of x-ray therapy. All the anastomotic segments were not removed and tested until at least eight days after completion of radiotherapy. This time interval (a minimum of eight and a maximum of 23 days) allowed the intestine to recover from the acute radiation injury. This observation was corroborated by histological sections which revealed, at seven to nine days, mucosal regeneration and reduction in the submucosal edema and degenerative changes in the muscularis universally noted on the first few days following completion of x-ray treatment. This suggested that operative intervention should probably be delayed for at least seven days following completion of any planned preoperative irradiation. (BBB)

38473 RESISTANCE PRODUCED IN RATS AND MICE BY EXPOSURE TO IRRADIATED PLASMODIUM BERGHEI. **Wellde, B. T.; Sadun, E. H. (Walter Reed Army Inst. of Research, Washington, D. C.). Exp. Parasitol., 21: 310-24 (Dec. 1967).**

Rats infected with Plasmodium berghei-parasitized erythrocytes irradiated with doses up to and including 16,000 R developed progressive parasitemias with obvious parasite multiplication and reinvasion of RBC's. Some rats receiving parasitized RBC's irradiated at levels of 17,000 and 18,000 R did not develop progressive infections. Infections were aborted by exposure to irradiation at 19,000 R or higher. Inoculation with parasitized blood exposed to 20,000 R stimulated a resistance to a challenge infection with nonirradiated parasites. The peak parasitemias reached in the immunized animals were significantly lower than those of the nonimmunized controls and reduction in parasitemias began much earlier. The degree of acquired resistance induced by inoculation with irradiated parasites was influenced by the number of immunizing exposures before the challenging infection. The acquired resistance induced by irradiated infected RBC's could be detected also in a more susceptible animal such as the mouse. Twice-weekly inoculations of irradiated parasitized cells given three, five, and 10 times extended the mean survival time after challenge considerably; a significant number of mice survived otherwise lethal infections. In both rats and mice the degree of acquired immunity was directly proportional to the number of immunizing doses. Similar results were obtained when immunizations occurred at weekly intervals or when given twice weekly. Likewise, no significant differences were detected when the challenge took place one or two weeks after the last immunizing dose. (BBB)

38474 BIOLOGICHESKOE DEISTVIE PROTONOV VYSOKIKH ENERGII (K OTSENKE RADIATSIONNOI OPASNOSTI KOSMICHESKIKH POLETOV). (Biological Effects of High-Energy Protons (Evaluation of Radiation Contamination During Cosmic Flights)). Grigor'ev, Yu. G. (ed.). Moscow, Atomizdat, 1967. 508p.

Radiobiological problems initiated by cosmic flights and exposure to ionizing radiation doses during cosmic flights are discussed. Methods of calculating permissible radiation doses for cosmonauts are reviewed. Physical aspects of radiation protection during cosmic flights are analyzed and effects of high-energy protons on biological tissues are evaluated. Radiobiological effects of protons on mammals, birds, and plants are reviewed. Data are given for the clinical physiological studies carried out on personnel working with accelerators. Prophylactic and therapeutic measures for radioinduced injuries during cosmic flights are discussed. (H.L.W.)

38475 ASSESSMENT OF THE STATE OF HEALTH AND PRINCIPLES OF PLACEMENT FOR PERSONS SUBJECTED TO THE ACTION OF IONIZING RADIATION. Gus'kova, A. K.; Baisogolov, G. D. Med. Radiol., 13: No. 5, 3-9(May 1968). (In Russian).

Data are presented for use by physicians for evaluation of the state of health of persons exposed to ionizing radiations because of their occupation. (C.H.)

38476 SPECIFICITY OF THE BIOLOGICAL ACTION OF HIGH-ENERGY PROTONS. Benevolenskii, V. N.; Gertsusskii, D. F.; Govorun, R. D.; Grugor'ev, Yu. G.; Derbeneva, N. N.; Popov, V. I.; Ryzhsov, N. I.; Seraya, V. M. (Inst. of Medical and Biological Problems, Novosibirsk, USSR). Med. Radiol., 13: No. 5, 9-15(May 1968). (In Russian).

The biological effects of high-energy protons (126 to 660 MeV) are reviewed. Analysis of experimental materials and pertinent literature indicated that there were no qualitative differences in proton lesions in comparison with standard types of radiation lesions induced by γ- and x-rays. The coefficients of the proton biological effect for different biological objects, judging by many tests, were 1 or less. In a number of cases, especially in plants, radiation lesions were manifested much more markedly than those induced by γ and x rays; as a result of this, the coefficients of proton biological effect on these objects somewhat exceeded 1. The differences did not depend on the radiation lesion since these values for protons of high energy and γ radiation were nearly identical. It is concluded that the difference in the biological effect of high-energy protons and standard radiations is possibly associated with spatial microdistribution of ions and radicals and depth dose distribution. (auth)

38477 HEMATOLOGICAL DISTURBANCES IN CHRONIC RADIATION EFFECT. Sokolov, V. V.; Gus'kov, A. K. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Med. Radiol., 13: No. 5, 24-8(May 1968). (In Russian).

The assessment of blood changes following protracted exposure of man to ionizing radiation up to the present time was restricted to individual symptoms. Numerous observations at late periods of persons exposed to ionizing radiation indicated two variants characterizing the stage of restorative processes in the bone marrow after discontinuation of radiation exposure or after its diminution to permissible levels. These restorative processes depend on the degree of bone marrow hypoplasia developing in response to radiation injury that is manifested in the peripheral blood picture. This information on the pathogenic nature of hematopoietic disorders improves the diagnosis of chronic radiation injury and helps in planning the treatment of patients. (auth)

38478 STUDY ON MICROMELIAS IN THE MOUSE FETUS CAUSED BY X RADIATION, HYPOXIA, TRYPAN BLUE INJECTION, OR HYPERVITAMINOSIS-A IN MOTHER ANIMALS DURING PREGNANCY. Kameyama, Yoshiro; Nogami, Hiroshi; Muramaki, Ujihiro (Nagoya Univ., Japan). Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ., 12: 29-41(1964).

Pregnant ddN strain mice were subjected to a single dose of whole-body x radiation of 200 or 300 R between the eighth and 13th day of pregnancy. Other mice were exposed to reduced atmospheric pressures (225 mm Hg) for five hr, a single intraperitoneal injection of 0.1 ml of 2% trypan blue saline solution, or a single intraperitoneal injection of 15,000 I.U. vitamin A water-miscible solution from the eighth to 13th day of pregnancy. Incidence of malformation of the extremities, especially micromelias, was recorded. Critical periods for micromelias were as follows: on the 10th fetal day by hypoxia, on the 11th day by x irradiation or trypan blue injection, and from 11th to 12th day by hypervitaminosis A. Micromelias caused by the different kinds of agents had different characteristics. In those caused by x radiation, ectrodactylisms were rarely complicated. Even when the x-ray dose was increased, the critical period was not extended. In the forelimb, deficiency of the long bones was not seen but a tendency to form synostosis was evident. In those that resulted from hypoxia, shortening of the extremities occurred only in the hindlimb, and in those cases, deficiency of the tibia was often seen. In those that originated from hypervitaminosis A, the incidence of typical micromelia was abundant. These presented an appearance termed phocomelia. However, in some ways there were differences between phocomelias in human beings as caused by thalidomide and experimental micromelias in the mouse. (BBB)

38479 LETHAL EFFECT AND VISIBLE IRRADIATION DAMAGE. Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 53-70(Jan. 1968).

Results are reported from a study on the relationship of lethal effect to growth suppression and visible radiation injury in 12-day old larvae of the salamander known as the mexican axolotl (Siredon mexicanum) exposed to doses of x radiation ranging from 100 to 3,000 R. The findings showed that observable changes in the tissues can be extremely small even in the last animals surviving a dose as large as 2,000 R, in spite of the generally lethal effects of all doses from 100 R up. The lethal effect was attributed primarily to radioinduced degeneration of the spleen. It is pointed out that the spleen is probably the only blood forming organ in the animals at this early stage in their development. (C.H.)

38480 ENERGY ABSORPTION SPECTRA DURING INCORPORATION OF ALPHA-EMITTING NUCLIDES. Kappos, A. D. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). pp 569-81 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In German).

See EUR-3747; CONF-671109.

If alpha-emitting nuclides are incorporated in the animal or human organism, the radiation occurring during decay is locally markedly non-homogeneous. The average radiation dose is therefore of little use. More information for research into the mechanisms of the radiation effect is obtained if it can be ascertained how often elementary biological units (e.g., cells, mitochondria etc.) absorb a given amount of energy. Such frequency distributions of the absorbed energies are calculated for idealized models. One model refers to a homogeneous distribution of the incorporated nuclides in the biological material (e.g., thorotrast-spleen), and another to selective accumulation of the nuclide in particular structures (e.g., radium in bones). The absorbing biological units are assumed to be spherical, the radius varying between 0.1 and 10 μ. In the calculations, the alpha-particle is assumed to have a straight path. The calculations are carried out for various initial particle energies. The energy range equations taken as the basis are adapted to the best theoretical and experimental data available. Allowance is made for energy loss at right angles to the particle path (e.g., by δ-particles). Some of the resulting spectra are given. (auth)

38481 THRESHOLD DOSE AND RADIOCARCINOGENESIS IN C57 BLACK MICE. Mewissen, D. J. (Univ. of Brussels). pp 1376-80 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Data are presented from a series of studies on the incidence of lymphosarcomas, other malignant tumors, and benign tumors in C57 mice following exposure at 35 day of age to a whole-body dose of 280 R x radiation, delivered in one or two equal doses. Data are also included on the effects of thymectomy on the incidence of radioinduced neoplasms and on the carcinogenic effects of injections of various doses of ^{3}H-thymidine within 12 hr following birth. A review of the findings led to the conclusion that, as a result of methodological limitations, estimation of a threshold radiation dose for carcinogenesis in mice through establishment of a dose-response relationship appears impracticable in the light of present experimental knowledge. (C.H.)

38482 RETROSPECTIVE STUDY OF THE POSSIBLE TERATOGENIC EFFECTS OF DIAGNOSTIC PELVIC X IRRADIATION. Jacobsen, L.; Mellemgard, L. (Rigshospitalet, Copenhagen). pp 1372-5 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Children of a group of 200 women who had received diagnostic radiation were divided into three groups: those born prior to irradiation of the mother; those exposed in utero; and those conceived and born during a certain interval following exposure of the mother to irradiation. Evaluations of chronic diseases and

gross visible congenital malformations were carried out. No definite differences in the three groups could be demonstrated. Among the grandchildren of the first group, ocular defects, including coloboma of the choroid and iris and atrophy of the iris, were observed. (H.L.W.)

38483 LATE INJURIES FROM LOW-DOSE IRRADIATIONS. Moskalev, Yu. I.; Streltzova, V. N. (Inst. of Biophysics, Moscow). pp 1364-71 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Experimental and clinical research showed that it was necessary to define the term small dose according to observed effects at the molecular and cellular levels, in tissues, organs, or the whole organism. The values of small doses that were determined for protons were: 5 rad for tumors of the hypophysis and thyroid gland of rats; 20 rad for mammary gland tumors; 40 rad for leukosis; and 60 to 100 rad for tumors of bone, kidneys, and gastrointestinal tract. The values of small doses of fast neutrons for rats were 5 rad for leukosis and tumors of the hypophysis and thyroid gland; 8.5 rad for tumors of the gastrointestinal tract, kidneys, and testes; and 15 rad for mammary gland tumors. The values of small doses of ^{90}Sr, ^{144}Ce, and ^{239}Pu introduced parenterally are 0.05, 0.075, and $0.06 \cdot 10^{-3}$ mCi/g for bone tumors. The values of small doses can have different parameters not only for different reactions but also for the same reaction; this is explained by the peculiarities of the reaction examined, by the state of the organism or the tissue, or by conditions of the radiation and its properties. (H.L.W.)

38484 DEFINITION AND LIMITS OF THE CONCEPT OF "SMALL DOSE" OF IONIZING RADIATIONS IN MAMMALS. Rugh, Roberts (Columbia Univ., New York). Contract AT(30-1)-2740. pp 1356-63 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol. 2).

The term small or low dose of ionizing radiations is relative to the experience and interests of the investigator, relative to the tissue, organ, or area of the recipient concerned, and relative to the object desired. To the therapist the smallest dose, coned to a malignant area, must be lethal to the malignancy but not to the host. The therapy dose may reach thousands of R and still be too small to be effective. To the diagnostician a small dose may be less than 20 R in a combination of fluoroscopy and conventional radiographs, before he is able to define the malignancy. To the radiobiologist a small dose would be less than 15 R, known as the maximum permissible dose for any one year for atomic workers, and presumably a dose without permanent and damaging somatic effects. To an embryologist a small dose might be 5 R, which is still enough to cause congenital anomalies if delivered at certain times following conception. To a geneticist there is no small dose. To the radiogeneticist exposure of the gonads to any man-made radiation is too much. Data are tabulated on doses of ionizing radiations that affect mammalian tissues or behavior. It is suggested that 25 R be considered a relatively low dose for radiobiological studies. A review of data from a number of studies led to the conclusion that the impact of ionizing radiations upon any biological system is instantaneous, but the biological response may be delayed for decades or even for generations. The time lapse between exposure and the biological expression bears no relation to the dose, especially at low levels. There is no sharp threshold for any biological effect, which may be a reflection of the normal biological variability in a heterozygotic population. The latency in tumorigenesis following x irradiation may be caused by a somatic mutation in a single cell that takes from 17 to 35 or more years to derive a palpable, malignant mass. The threshold of radiation-tumor development seems to be related to the tissue, to the age of the organism, and to its genetic susceptibility. Ionizing radiations comprise a major and essential tool in medical practice, but, if misused or misdirected, may have insidious effects on present and future generations. We must protect the germ cells and the embryo or fetus against any unnecessary irradiation. For them no low-dose threshold has been established. Therefore, for the therapist the low dose concept has a very different meaning than it does for the diagnostician. For the diagnostician any unnecessary radiation is too much, especially when it involves the reproductive cells or the developing embryo and fetus. (C.H.)

38485 CONCEPT AND ACTION OF "SMALL RADIATION DOSES" IN RADIOBIOLOGY. Rajewsky, B. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). pp 1337-51 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol. 2).

Small radiation doses are defined as doses up to about 200 R. It is pointed out that in general, the radiation effects caused by small radiation doses in biological systems represent the results of compound reactions. The analysis and explanation of these reactions is often more difficult than in the case of irradiation effects at high and very high doses. From a practical point of view, it is often more useful to clarify the different possible processes in the range of high radiation dose-rates and radiation doses. Results are reviewed from a number of experiments on the radiation biology of mammals and other living organisms exposed to various small doses of x radiation. It was concluded that the radiation effects in different cells, cell systems, and organisms are extremely varied. Generally, these effects depend on the size of the radiation dose, on the radiation dose-rate, and on the LET: they are quantitatively different for different biological objects. It has not been possible to establish reliable qualitative differences in irradiation effects on different cell systems and on different organisms. Present-day methods of observation and measurement offer the possibility of investigating certain irradiation effects from very small doses. The lowest limit of ascertainable observation is within the range of radiation doses of 0.1 to 1 R. Such effects include, for example, changes in the white blood elements produced by irradiation and reactions of the nervous system in mammals. It is possible to investigate the effects of radiation doses on various organisms within the range 5 to 20 R with acceptable accuracy and without great experimental difficulty. At higher dose-rates, nearly all known irradiation effects are detectable. Exact criteria for the limitation of the range of small doses in the direction of higher doses do not exist. It is, however, possible to list certain characteristics of the effects of small doses of radiation, e.g., the summation of the radiation effect. The accurate detection and determination of the threshold value of effective radiation dose is possible in theory but has not as yet been carried out. On the contrary, the dose necessary to obtain a demonstrable radiation effect is continually being lowered as more refined methods of observation are applied to carefully devised experiments. The rate of the manifestation of an irradiation effect is of great importance. The lifespan of the irradiated organisms is as yet the most important limiting factor in the detection of the irradiation effects. Different mechanisms of the action of radiation can result in the same end-effect. These mechanisms are nearly all compound or superimposed reactions. The radiation-induced chain reactions may take place in parallel, reinforcing or counteracting one another. Due to certain partial or secondary reactions, the manifestation of other reactions can be blocked, and thus give rise to a dose-independent irradiation effect and an apparent compensation for the effect of the irradiation. (C.H.)

38486 MODIFICATIONS OBSERVED IN BONE TISSUE DURING CHRONIC IRRADIATIONS BY INTERNAL METHODS. Zedguenidze, G. A.; Amossov, I. S. (Inst. of Medical Radiology, Moscow). pp 1522-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Over a period of three to five years 280 rabbits were observed during their entire lives. Several injections of Thorotrast were given over a period of two months by way of the ear vein and the jugular vein. Electron microscopy was used to determine the formation of crystals of thorium dioxide in certain organs. Clinical observations revealed leukosis, dystrophy of osseous tissue, and osteosarcoma. During the first and second years cachexia, premature aging of adipose tissue, and skeletal deformities were observed. The distribution of Thorotrast particles occurred by focal accumulation within the organs and by hepatic and splenic migration. Photographs of radiograms and histologic structure of Thorotrast-induced tumors are presented. (H.L.W.)

38487 RECENT STUDIES ON SURVIVORS OF THE NUCLEAR EXPLOSIONS AT HIROSHIMA AND NAGASAKI. Tsukamoto, Kempo (National Inst. of Radiological Sciences, Chiba, Japan). pp 1499-1507 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Twenty years have passed since atomic bombs were dropped on Hiroshima and Nagasaki in August, 1945, but many problems on the effects of radiation on man are still unsolved. Results are reported from recent attempts to estimate the radiation dose

delivered during the explosions; estimations of the incidence of leukemia, thyroid neoplasms, and other malignancies among the survivors; the incidence of chromosome abnormalities in survivors in relation to distance from the explosion hypocenter; and the incidence of hereditary and developmental abnormalities in the offspring of survivors. (C.H.)

38488 COMPARATIVE RADIOBIOLOGICAL STUDIES ON TISSUE CULTURES. Korogodin, V. I.; Korogodina, Yu. V. (Inst. of Medical Radiology, Obninsk, USSR). pp 1391-5 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The principal distinction between the response to γ and x radiations of microorganisms and mammalian cells in culture is quantitative rather than qualitative: different doses are required to induce a similar effect, but the general pattern of response in both cases is identical. It is possible that the high radiosensitivity of animal cells is due to the larger size of their nuclei. Radiosensitivity of mammalian cells in vivo is approximately of the same order as that under culture conditions. However, a number of differentiating animal tissues exert massive lethality soon after irradiation in relatively low doses, the so-called interphase death. It is believed that this very phenomenon is the principal distinction by which response to radiation of animal cells in vivo can be distinguished from the corresponding response in vitro and of that of unicellular organisms. Quantitative relations of interphase death have not yet been demonstrated. (auth)

38489 FRACTIONATED IRRADIATION AND THE EFFECT OF OXYGEN. Revesz, L.; Littbrand, B. (Karolinska Inst. Medical School, Stockholm). pp 1476-81 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results are reported from studies on the survival of cultured hamster cells following exposure to various doses of x radiation delivered as a single dose or two equal doses in oxygen or argon. Results showed that a single dose of 400 R was about twice as effective in decreasing survival as the same dose delivered in two equal fractions. The results suggest that a certain amount of repair of radiation injuries takes place in cells irradiated under aerobic conditions. Possible implications of the findings in establishing radiation dose fractionation schedules for the radiotherapy of neoplasms in man are discussed. (C.H.)

38490 NEW DATA ON THE EXPOSURE OF THE HUMAN POPULATION TO IONIZING RADIATION. Warren, Shields; Lombard, Olive M. (New England Deaconess Hospital, Boston. Harvard Cancer Commission, Boston). Contract AT(30-1)-901. pp 1508-13 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (NYO-901-38).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

In the past the average life-span of United States radiologists was shorter than that of United States adult white males. Since 1935 this life shortening has lessened, most strikingly since 1945, and disappeared by 1960. In recent years the incidence of leukemia in radiologists has decreased. Leukemia occurs rarely and only after a number of occupational exposures in radiologists. The age pattern of incidence of leukemia is quite different in radiologists and United States white males, over age 25. Data strongly suggest that current occupational maximal permissible dose levels provide adequate protection. (auth)

38491 STUDIES ON BONE-SEEKING RADIOISOTOPES. Rowland, R. E. (Argonne National Lab., Ill.). pp 1530-6 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Current knowledge of levels of radioactivity in the human skeleton is reviewed. It is pointed out that high-level radium cases, on whom all present evaluations of toxicity are based, are characterized by a lack of uniformity in the deposition pattern of this isotope. Their exposure history started in adulthood and their period of exposure was brief compared to their lifespan. Dose distributions for these bones, calculated from the observed hot-spot and diffuse distributions, showed that the dose distribution to the cells thought to be largely responsible for the toxic effects, from the diffuse distribution, was only a few hundred times as great as the normal or background dose to the same cells. Furthermore, this calculated dose was probably too high, due to the cleaning action of exchange working on bone surfaces. Lastly, bone remodeling often places new unlabeled bone adjacent to bone surfaces, reducing the number of cells at risk in these cases. In contrast, the human population was found to be uniformly labeled with alpha-emitting isotopes throughout life. This normal distribution is unaffected by exchange and remodeling processes, for the newly-deposited mineral contains the same tracer concentration as the old bone. Thus it is significant to point out that it is difficult to calculate the expected risk, due to relatively constant low radiation levels to large populations, on the basis of the observed toxic effects in the radium cases. The difference in dose distributions between the two groups may be smaller than that expected on the basis of the total isotope content alone. These new findings may indicate that the dose response for alpha-emitters in bone may be very steep. These considerations point to the necessity of re-evaluating the effects of natural levels of radioactivity on man. (auth)

38492 COMPARATIVE STUDIES ON CHROMOSOMAL ABERRATIONS IN MAN INDUCED BY IRRADIATIONS UNDER VARIOUS CONDITIONS. Sugahara, T.; Doida, Y. (Kyoto Univ.). pp 1435-40 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The types and incidence of chromosomal aberrations in peripheral blood leukocytes were studied in persons irradiated under various conditions. The samples were taken at various intervals after irradiation. The percentage of aneuploidy and dicentric chromosomes was compared between the various types of aberrations. Single and fractionated exposures with different dose-rates, and whole-body and partial-body exposures, resulted in differences in the incidence and type of aberrations. These differences may better be explained by the differences not only in radiation response but also by kinetic analysis of the cell renewal system. (auth)

38493 EXPERIMENTS ON THE RADIOSENSITIVITY OF TRANSPLANTABLE LYMPHATIC TUMOURS. Silini, Giovanni (Centro Studi Nucleari della Casaccia, Rome). pp 1410-17 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results are reported from studies on the effects of various doses of x radiation on the survival of cultured ascites tumor cells following transplantation in mice. The effects of dose fractionation or treatment with radiosensitizing drugs (5-bromodeoxycytidine and 5-fluorodeoxyuridine) on the survival of irradiated cells were also studied. Observations made on two newly isolated strains of transplantable ascites leukemia are reported in which the number of irradiated tumor cells required to produce 50% leukemia in the implanted animal within a period of two months from intravenous injection of the cells was used as the end-point. (C.H.)

38494 MITOTIC DELAY OF HUMAN CELLS IN TISSUE CULTURE IRRADIATED AT DIFFERENT PHASES OF THE GENERATION CYCLE. Bootsma, D. (National Defence Research Organization, TNO, Rijswijk, Netherlands). pp 1404-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The effect of 200 R x radiation given in a dose rate of 200 R/min on mitotic activity during different phases of the generation cycle were studied in monolayer cultures of T cells (of human kidney origin). Lower doses affected a smaller part of the population. It was found that after 50 R only G_2- and a few S-phase cells were delayed. This gave rise to a smaller but higher peak of mitotic figures soon after the recovery of mitotic activity. Irradiation with higher doses, e.g., 400 R, caused a longer delay of irradiated G_1-phase cells, but this delay was shorter than that incurred by irradiated S-phase cells, which in turn were shorter than that of irradiated G_2-phase cells. A comparison was made of the effect of irradiation on two related cell-lines, isolated from the same parent line, and it was found that between related cell-lines differences occurred in the duration of mitotic delay and the degree of synchronization induced by x rays. Cells irradiated in an earlier phase of the division cycle always suffered shorter delays in division time. (auth) (TSS)

38495 RADIOSENSITIVITY OF TUMOUR CELLS CULTIVATED IN VITRO. Benassi, Enrico; Piccotti, Franco (Univ., Turin). pp 1396-1403 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Results are reported from studies on the effects of ionizing radiations on the growth of Ehrlich ascites tumor cells in cultures and in mice. It is pointed out that cellular adaptation to culture growth conditions, whatever the origin of the cells, involves a series of similar morphological, functional, and nuclear changes that tend to complicate the assessment of radiosensitivity since the degree of radiosensitivity of the established in vitro cell population may be different from that of the original cell population. The growth of in vivo cells was inhibited only by radiation doses of 2,000 rads or more, whereas growth of in vitro cells was inhibited by doses of 500 rads. Variations in the percentage survival of in vitro and in vivo cells irradiated with increasing doses before inoculation into mice subjected to 400 rads of whole-body irradiation were determined. Tumor transfer potential was impaired to a greater extent in the in vitro than in the in vivo cells. The possible effects of adaptation to culture conditions, the high chromosome count found in cultured cells, the decreased number of mitochondria in cultured cells, and rapid repair of radiation damage under in vivo conditions on the results reported are discussed. (C.H.)

38496 SO-CALLED "RADIOMIMETIC EFFECTS" AND CELLULAR ALTERATIONS INDUCED BY MAGNETIC FIELDS. Lenzi, Mario (Univ., Modena, Italy). pp 1747-52 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In Italian).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol. 2).

The possible effects of magnetic fields on the mitosis and metabolism of normal and abnormal mammalian cells in vivo and in vitro are discussed. Experimental results, as well as a review of the literature, appear to provide evidence of this action. The need of further planned studies, with special reference to the problems connected with space biology, is emphasized. (auth)

38497 PROPHYLAXIS AND TREATMENT OF INTESTINAL DAMAGE DUE TO IRRADIATION. De Giuli, G.; Dalla Palma, L.; De Dominicis, R. (Univ., Florence). pp 1609-16 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

A review of clinical, morphological, and functional manifestations of radiation injuries of the intestine following fractionated therapeutic irradiation of patients led to the conclusion that the alimentary manifestations are related to damage not only to the gastrointestinal tract but also to reactions of the adrenal glands, the autonomic nervous system, the liver, the pancreas, and other organs. The primary radiobiological effects are interrelated to changes in intestinal motility, blood-lymphatic circulation, and intestinal flora to such an extent that the resulting damage is independent of the initial cause. Therapeutic measures include sedation; the use of anti-inflammatory drugs; substitutive treatment with vitamins, lipids, carbohydrates, nitrogenous substances, electrolytes, and water in an attempt to remedy absorptive defects; diet; and nursing care. (C.H.)

38498 PROPHYLAXIS AND THERAPY OF RADIATION INJURIES. Kolar, Jaromir (Karls-Univ., Prague). pp 1617-23 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The present state of the prophylaxis of radiation-induced skin and bone lesions, based on observation of 481 cases of skin damage and 443 of bone damage, is still unsatisfactory. More than twenty percent of persons with radiation-induced skin lesions will subsequently develop a malignancy; its prevention is possible by removing the diseased skin. The prognosis for radiation-induced malignant bone tumors is poor. (auth)

Radiation Effects on Plants

Refer also to abstracts 38184, 38192, 38228, 38230, 38238, 38241, 38242, 38263, 38278, 38476, 38485, and 38503.

38499 (JPRS-44845) ROLE OF NUCLEIC ACIDS AND PROTEIN IN THE RADIATION STIMULATION OF PLANT GROWTH. Grebinskii, S.; Fornyak, N. M.; Yatsevskaya, N. V. Translated from Dokl. Akad. Nauk SSSR, 177: 717-19(1967). 6p. CFSTI.

Studies were made on accumulation of proteins and nucleic acids and dry weight of corn shoots following x irradiation of seeds. Results are shown graphically. Doses of 750 rad produced a stimulating effect while doses of 25 rad produced an inhibiting effect. The radioinduced stimulation of growth resulted in an increased water content of plant tissues as well as increased amounts of nucleic acids and proteins. Both stimulating and inhibiting effects of irradiation were more pronounced in the root than in the stem. The activity of ribonuclease in corn seedlings was also increased following irradiation of seeds. Radish seedlings were irradiated with doses of 750 rad; the resulting stimulation of growth was accompanied by increased water content, nonprotein nitrogen, nucleic acids, and proteins. (H.L.W.)

38500 RADIOSENSITIVITY OF TOBACCO TO ^{60}Co γ RAYS DURING VARIOUS STAGES OF DEVELOPMENT. Tavdumadze, K. R.; Todua, V. A. (Abkhazsk Experimental Tobacco Station, USSR). Soobshch. Akad. Nauk Gruz. SSR, 49: 205-10(Jan. 1968). (In Russian).

Physiological effects in tobacco of various doses of ^{60}Co γ rays were studied. It was found that doses of 2.5 and 4.5 Ci stimulated seeds, 0.2 and 0.5 Ci on seedlings, and 1.5 and 2.5 Ci on pollen. An inhibiting effect was produced in seeds by 20 and 25 Ci, on seedlings by 1.7 and 2.0 Ci, and in pollen by 7 Ci. Lethal effects were induced in seeds by 50 to 60 Ci, in seedlings by 2 Ci, and in pollen by 10 Ci. The radiosensitivity of tobacco varied with the stages of development. A maximum radiosensitivity was observed during the highest physiological activity and cell reproduction period, and the lowest radiosensitivity was found during the dormant stages. No morphological changes were observed in plants that developed from irradiated pollen. (R.V.J.)

38501 DIRECT AND INDIRECT EFFECTS OF SHORT-TERM IONIZING RADIATION ON OLD-FIELD SUCCESSION. **Daniel, Charles P.; Platt, Robert B. (Georgia Coll., Milledgeville). Ecol. Mongr., 38: 1-29(Winter 1968).**

Old-field succession was studied at a site that received ecologically significant doses of γ and neutron radiation from an air-shielded nuclear reactor. The data included an account of the changes in species composition from season to season due to competition and irradiation, correlation of the life cycle of certain species with their sensitivity to radiation, indirect effects (such as stimulation) when a species was released from limiting competition as a result of irradiation, damage in relation to dose for certain dominants, and partial shielding effect of the soil to underground plant organs. A short-term dose of 8500 rad in June on first-year communities had little observed effects, but 30,000 rad in August on first and second year annual communities resulted in an open canopy the following year by elimination of the tall forb, Haplopappus, which produced only sterile seed. Soil-shielded buds of perennials were protected from damage by radiation. Monarda punctata, although producing sterile seed, maintained dominance by vegetative reproduction. Standing crop dry weight biomass was reduced by irradiation on a per unit area basis. Communities receiving a gradient of 6900 to 90,000 R changed from random distribution to dominance bands around the source, according to the interaction between the relative radiation sensitivity of particular species and release from competition. Life cycles for many species were shortened by radiation stress, in that germination was delayed and flower and fruit production was earlier. Of the dominants, Haplopappus divaricatus was the most sensitive to irradiation. Its upper stems with their flowers were killed by 30,000 rad. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 38115, 38192, 38193, 38278, and 38485.

38502 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFICIENCY OF 20-MeV PHOTON AND ELECTRON BEAMS. CHAPTER VI. RELATIVE BIOLOGICAL EFFECTIVENESS OF X RADIATION OF CONVENTIONAL AND LOW ENERGIES. Wambersie, A. J. Belge Radiol., Monogr. 1, 104-24(1967). (In French).

The RBE of x rays of classical energy and low energy was studied. The survival of E. coli was the biological test used. No significant difference was found in the RBE of the energy regions studied. A very precise analysis shows the existence of a small difference of RBE between the x rays of 98 and 43 keV. (J.S.R.)

38503 CONTRIBUTION TO THE STUDY OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BEAMS OF PHOTONS AND 20-MeV ELECTRON BEAMS. CHAPTER II. RELATIVE BIOLOGICAL EFFECTIVENESS OF ^{60}Co, 20-MV PHOTONS, AND 20-MeV ELECTRONS ON SURVIVAL OF E. COLI AND SACCHAROMYCES CEREVISIAE. Wambersie, A. J. Belge Radiol., Monogr. 1, 41-52(1967). (In French).

The RBE of ^{60}Co γ, 20-MeV photons, and 20-MeV electrons were determined, using the survival of E. coli and the diploid yeast Saccharomyces cerevisiae as the biological test. The doses were

determined using chemical dosimetry with $FeSO_4$. The two biological systems, bacteria and yeast, responded in a similar manner and no significant difference could be detected among the three radiations. (tr-auth)

38504 THE ACTION OF HEAT AND IONIZING RADIATION ON THE INFECTIVITY OF ISOLATED φX-174 DNA. Hotz, G.; Mueller, A. (Nuclear Research Center, Karlsruhe, Ger.). Proc. Nat. Acad. Sci., U. S., 60: 251-7(May 1968).

The sensitivity of isolated dry φX-174 DNA against inactivation by heat and ionizing radiation between 4.2 and 433°K (160°C) was investigated by assaying the plaque formation after infection of Escherichia coli spheroplasts. The effect of heat alone was found to rise steeply above 120°C, while the radiosensitivity begins to increase markedly at 50°C but remains practically constant at lower temperatures. Both actions were observed up to 160°C, at which temperature the radiosensitivity was about seven times that at room temperature, corresponding to an inactivation efficiency of at least two. This high value is attributed to the participation of radiation-produced atomic hydrogen in the total inactivation. This conclusion is supported by an activation energy of 6.3 kcal/mol by which the temperature-dependent inactivation is characterized. The corresponding value for heat inactivation is 24.5 kcal/mol. The results are also discussed in terms of the thermal spike model. It is concluded that the partial agreement is fortuitous. (auth)

38505 INHIBITION OF BACTERIAL CELL GROWTH BY 136 gc MICROWAVES. Webb, S. J.; Dodds, D. D. (Univ. of Saskatchewan, Saskatoon). Nature (London), 218: 374-5(Apr. 27, 1968).

It was found in experimental work with E. coli B that microwaves appeared to have an effect on cell metabolism. Some preliminary findings are reported. Exposure was for periods up to 4 hr. If the washed cells were immediately exposed to the microwaves no cell divisions occurred. The radiation was not lethal, since the cell count showed no decrease during 4 hr. If the cells were incubated in nutrient broth for 90 min. before exposure to the radiation, inhibition of cell division was not immediate, and the number of cells/ml. continued to increase until it had approximately doubled. It is suggested that the radiation had two effects — slowing down of cell division and specific inhibition of some metabolic process occurring during the early part of the cell life span. (UK)

38506 HOST-CELL REACTIVATION OF ULTRAVIOLET-DAMAGED PHAGE IN STREPTOCOCCUS PYOGENES. Maike, Horst (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Biochem. Biophys. Res. Commun., 29: 400-5(Nov. 17, 1967).

Stationary phase cells were grown in serum broth and bacteria and phage were suspended in buffer solution for ultraviolet irradiation. Hcr mutants were isolated and treated with N-methyl-N'-nitro-N-nitrosoguanidine in phosphate buffer. Results are presented in the form of graphs to show survival of phage on Streptococcus pyogenes K 56 Hcr^+ strain and on five Hcr^- mutants of independent origin and to show survival of colony forming ability of S. pyogenes. The effects of caffeine and acriflavine on phage survival in mutant strains were investigated. Acriflavine reduced the survival of ultraviolet irradiated phage. (H.L.W.)

38507 EXPERIMENTAL BIOLOGICAL BASES OF THE OXYGEN EFFECTS. Powers, E. L. (Univ. of Texas, Austin). Contract AT(40-1)-3408. pp 1451-7 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

Mechanisms involved in the effects of oxygen on the radiosensitivity of biological systems were investigated in dry spores of Bacillus megaterium with the water content, gaseous atmosphere, and temperature controlled before, during, and after exposure to various doses of x radiation. The survival of colonies produced by the spores was used as a measure of radiosensitivity. Tests for early radiation effects and their modification were conducted in physiologically inert cells. Results showed that the total oxygen effect on radiosensitivity was the result of two effects, one of which was brought about by the reaction of free radicals with oxygen and the second effect was observed only if oxygen was present during irradiation. Characteristics of the oxygen effect that are discussed include response to temperature, response to changes in LET, dependence upon water, and the effects of metabolic factors. Applications of the findings in cancer therapy by using oxygen to increase the radiosensitivity of anoxic tumors without injury to well oxygenated healthy tissues are discussed. (C.H.)

Radiosterilization and Radiopreservation

38508 (AED-C-05-07) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 05. RADIATION EFFECTS ON FOOD. Schmidt, H. D.; Beising, Kurt (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Sept. 1967. 126p. (In several languages). Dep.

Approximately 500 references are presented to literature on the radiation processing of foods. (C.H.)

38509 STERILIZATION OF FOODSTUFFS BY IRRADIATION AND THEIR EVALUATION UNDER THE FOOD LAWS. Worseck, M. (Veterinary Research and Animal Health Office, Potsdam, Ger.). Monatsh. Veterinarmed., No. 10, 366-9(1966). (In German).

A general review of current food irradiation processes and of the application of pure food laws is presented. The feasibility of replacing conventional food handling processes by irradiation methods is discussed. After a thorough review of experiments to date on food irradiation, it is concluded that all technical aspects of the question have, to all intents and purposes, been elucidated. Not only are the dosages required for specific objectives known but these dosages are generally admitted to be far below those thought to jeopardize health by giving rise to toxic or cancerogenic substances. Furthermore, the initial fears of adverse effects observed in experimental animals have not been borne out by subsequent, long-term testing, and the initial results have been interpreted in a new light, e.g., hemorrhage owing to lack of vitamin K rather than to the direct effects of irradiation. While economic considerations continue to limit the industrial use of irradiation for the processing of foodstuffs, the results obtained with these methods behoove highly developed countries to keep constantly abreast of pertinent developments. (ATD)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 39955.

38510 (BNL-50082, pp 93-152) METALLURGY AND MATERIALS SCIENCE DIVISION. Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.).

Corrosion of heat-resisting alloys by high-purity Na at 660 to 760°C is being tested. Progress is reported on development of Co-base alloys for Na-cooled fast reactor fuel cladding. Corrosion tests are reported on Cu, Fe, and Ni in liquid sodium along with results of a program designed to further the understanding of Na corrosion processes. Results of radiation effects tests on stainless steels, Co-base alloys, and Fe are reported along with results of tests on deformation of fast neutron irradiated iron and steel. Results of tests to determine physical and chemical properties of refractory compounds are reported along with data on thermodynamic properties of potassium-graphite compounds. Results of liquid metal studies concerned with self-diffusion, structures, densities, and electric properties are described and results of research on hysteresis in superconductors are discussed. (J.R.D.)

38511 ITTRII. (Yttrium). Terekhova, B. F.; Savitskii, E. M. Moscow, Izdatel'stvo Nauka, 1967. 160p.

Preparation of high-purity yttrium and the physical, chemical, magnetic, and electric properties of mono- and polycrystalline yttrium are described. All available constitution diagrams of binary and ternary yttrium systems with various elements are given and the behavior of yttrium alloys with light, rare, and high-melting metals is analyzed. Yttrium uses in technology, metallurgy, atomic energy, electronics, and medicine are discussed. (280 references.) (R.V.J.)

Corrosion and Erosion

Refer also to abstract 38535.

38512 (BNWL-763) LABORATORY INVESTIGATION ON CONTROLLING CAST IRON GALVANIC CORROSION IN COLUMBIA RIVER WATER. Larrick, Alvin P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

Results indicate that the probable cause of corrosion on K area diesel-engine powered emergency coolant pump bowls and vanes is galvanic current flowing between the brass impeller and the cast iron bowl. Methods of reducing corrosion are discussed. (J.R.D.)

38513 (CEA-N-856, pp 87-121) ETUDES DE CORROSION. (Corrosion Studies). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The behavior of Zr-Fe (2% Fe) and Zr-Fe-Cu (2% Fe and 2% Cu) in the cold-worked state or in the β-annealed-quenched state exposed to the effect of water vapor at 500°C for durations of 1 to 6 months was studied. The initial structure of the cold-worked alloy is characterized by numerous precipitates of warped form, but in the tempered state no trace of precipitation is detectable in the binary alloy. In the tempered alloys, maintenance in superheated vapor causes a regular precipitation; globulization of precipitates is observed in the cold-worked samples after long-time storage in superheated vapor. Studies on the pit corrosion of Fe-Cr-Ni austenitic steels showed that the attack of a stainless steel sample beginning with a pit can, under certain conditions, produce cavities separated from the environmental solution by a thin film. The metallic powder from the corrosion forms a deposit under which dissolution of the alloy is continued. Studies on the effects of additions of Mo and of Mo + Si on the corrosion of Fe-Cr-Ni austenitic alloys showed that these additions have a beneficial effect. Austenitic stainless steels, sensitized by storage at 700°C and polarized cathodically in nitric medium can undergo dissolution and intergranular attack simultaneously. Study of the behavior of a Cr steel with low carbon coupled to gold in nitric medium presented evidence of intergranular attack of an electrochemical nature. Studies were made on the behavior of zirconium alloys in water and superheated steam in order to follow the evolution of the weight increase, hydration, and oxygen diffusion. The results obtained are illustrated graphically and in tabular form. Corrosion tests at 350°C in demineralized and degased water containing 1 g/l of Cl^- ion were made on a series of Cr-Ni-Fe austenitic steels with 17% Cr and Ni contents from 10 to 77%. After extended corrosion under stress, fissures were detected in all the alloys with Ni. The fissures were transgranular for the 10% Ni alloy and intergranular for the 77% Ni alloy. The operation and results obtained with the gravitation moving bed resin pilot plant for the desalination of sea water were reported. The effects of the nature of the cation associated with the chloride ion, the presence of oxygen in the medium, and addition of Mo to the steel on the corrosion under stress of austenitic stainless steel with very low carbon content were investigated in boiling solutions of $MgCl_2$, $CaCl_2$, and NaCl. The results showed that the nature of the cation considerably affects the fissuring under stress. The presence of oxygen increases the aggressivity of the medium. Steels with additions of Mo are less sensitive to stress corrosion than steels without the Mo additions. (J.S.R.)

38514 (N-68-11617) CORROSION OF NIOBIUM-1 PERCENT ZIRCONIUM ALLOY AND YTTRIA BY LITHIUM AT HIGH-FLOW VELOCITIES. Hays, L. G. (Jet Propulsion Lab., Pasadena, Calif.). Dec. 1, 1967. Contract NAS7-100. 35p. (NASA-CR-90513; JPL-TR-32-1233). CFSTI.

An experiment was performed to measure the material removal from two materials—niobium-1% zirconium alloy and yttrium oxide—by a lithium stream flowing at a maximum velocity of 48.5 m/sec. After 109 hr at 1143°C, the yttria specimens were completely dissolved. After an additional 391 hr at 1073°C, the maximum depth of material removal from the niobium alloy was measured to be about 7 μm. This value corresponds to the depth calculated from turbulent mass-transfer relations for simple dissolution if the temperature coefficient of solubility is taken to be 1.2×10^{-9} g Nb/g Li °C. The measured variation of material loss with lithium velocity follows the dependency predicted by these relations, indicating a diffusion-limited process. (auth) (STAR)

38515 (RCN-91) SULFIDE, INTERGRANULAR, STRESS CORROSION CRACKING OF K-MONEL STUDS THAT FAILED DURING SERVICE IN HIGH TEMPERATURE, HIGH PRESSURE AUTOCLAVES AND IN A PRESSURIZED WATER PUMP. van der Linde, A. (Reactor Centrum Nederland, Petten). Nov. 1967. 34p. Dep.

K-monel studs failed by intergranular cracking after about 1000 hours service in autoclaves, operating at 300 to 400°C and 100 to 180 atmospheres with pure water, and after about 350 hours service in a pressurized, 340°C and 175 atmospheres, water pump. The investigations and failure reproduction experiments performed with respectively used and not used studs showed that sulfur, formed by decomposition of the fatty ingredient in Molykote G paste lubricant, was the attacking agent. Thus, at the roots of the stressed threads, the K-Monel surface was confronted with an increasing amount of sulfur, hydrogen sulfide or sulfur + hydrogen, during service. Moreover grain growth and copper diffusion to the grain boundaries, possibly in combination with bulk material sulfur diffusion to the grain boundaries, increased the material susceptibility for stress corrosion attack during service. In order to avoid this type of failures the available sulfur content in the nickel alloy surface environment as well as the sulfur content in the nickel alloy itself must be kept as low as possible. (auth)

38516 (WCAP-3269-56) CORROSION AND HYDRIDING OF ZIRCALOY UNDER HEAT TRANSFER CONDITIONS. Aqua, E. N.; Allio, R. J.; Thomas, K. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Aug. 1967. Contract AT(30-1)-3269. 57p. Dep. CFSTI.

The effect of heat transfer and isothermal conditions on the corrosion and hydriding of Zircaloy-4 tubing has been studied in a pressurized water system. In all of the systems studied, the oxidation was directly proportional to the clad surface (metal-oxide interface) temperature. Nucleate boiling, achieved with a maximum heat flux of 20,000 BTU/ft^2 hr, caused increased oxidation as compared with heat transfer systems using forced convection. The oxidation rate was inversely proportional to the difference between bulk water and clad surface temperatures. The hydrogen absorption was the same in the nucleate boiling systems as in the forced convection heat transfer systems, and homogeneous throughout the tube cross-sections. No abnormal platelet clusters were observed. (auth)

38517 OXIDATION OF Ti-Mo ALLOYS IN NITRIC ACID. Andreeva, V. V.; Kazarin, V. I.; Alekseeva, E. L. (Inst of Physical Chemistry, Moscow). Zh. Prikl. Khim., 41: 746-53 (Apr. 1968). (In Russian).

Studies of corrosion mechanisms in a Ti-Mo (40% Mo) alloy

in 34% nitric acid showed a much lower rate of corrosion of the alloy as compared with pure Mo. The rate of corrosion of the alloy increased with an increase in Mo content. (R.V.J.)

38518 OXIDATION OF NIOBIUM IN THE TEMPERATURE RANGE 450 TO 720°C. Sheasby, J. S. (Univ. of Western Ontario, London). J. Electrochem. Soc., 115: 695-700(July 1968).

The oxidation properties of niobium were studied in the temperature range 450 to 720°C at oxygen pressures 1 to 760 torr. Particular emphasis was placed on correlating the morphology of the reaction products with the oxidation kinetics. During the initial, approximately parabolic oxidation period the scale appears compact, and at the transition from parabolic to linear kinetics the scale blisters and cracks. Scale formed during linear oxidation grows in a series of crude layers. From the relationships determined between the rate of oxidation and the thickness of the oxide layers, it is deduced that the rate of oxidation is controlled at all times by the diffusional properties of the oxide layer in contact with the metal phase. The sensitivity of the rate of oxidation to oxygen pressure is ascribed to the pressure sensitivity of the underlying parabolic rate constant of formation of the niobium pentoxide, and to a lesser extent to changes in the width of the oxide layers with the rate of their formation. The inversion in the temperature coefficient of the oxidation reaction as the temperature is lowered from 625 to 600°C is associated with the disappearance of layers of NbO and NbO_2 from the reaction zone and the appearance of a metastable platelet phase. (auth)

38519 USE OF DISCONTINUOUS METAL FILMS IN DETERMINING THE RATE OF FORMATION OF VERY THIN OXIDE FILMS. Fehlner, Francis P. (Corning Glass Works, Corning, N. Y.). J. Electrochem. Soc., 115: 726-9(July 1968).

A new method for determining the low-temperature oxidation-rate constants of metals has been developed. The method is based on measuring the change in dc resistance of a discontinuous metal film when it is exposed to oxygen. Values of the logarithmic oxidation-rate constant (10^{-9} cm) for zirconium (1.8 to 10.3), titanium (0.2 to 4.0), niobium (0.8 to 3.2), and nickel (0.2 to 2.0) have been determined under the following conditions: 77 to 298°K and 10^{-6} to 10^{-8} torr oxygen. (auth)

38520 IMPROVED ZIRCONIUM BASE ALLOYS. (to Westinghouse Electric Corp.). British Patent 1,120,366. July 17, 1968. Priority date Jan. 10, 1966, United States.

A corrosion resistant Zr-base alloy composed of 0.1 to 2.5% Sn; 0.1 to 2% of a metal selected from Fe, Ni, and Cr; and 0.03 to 0.15% Mo is described. (J.R.D.)

Preparation and Fabrication

38521 (AWRE-O-39/68) PRODUCTION OF FINE METAL POWDERS USING GRINDING AIDS. Knight, R. A.; Calow, C. A. (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1968. 13p. Dep. CFSTI. UK 2s. 6d.

The object of the work described was to reduce −200 mesh Ni−Cr alloy powders to <10 μm particles size using mechanical comminution techniques. The addition agents were chosen mainly for their low sublimation and decomposition temperature since a decomposition process was selected to remove the grinding aid. (UK)

38522 (N-68-13625) DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY. Quarterly Progress Report, August 20–November 20, 1966. Buckman, R. W. Jr.; Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS3-2542. 40p. (NASA-CR-72316; WANL-PR-(Q)-013; QPR-12). CFSTI.

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued with the processing of compositions Ta−8W−1Re−Hf(ASTAR-811) and Ta−7W−1Re−1Hf−0.012C−0.012N(ASTAR-811CN) to 0.04 inch thick sheet. Primary breakdown of the 4 inch diameter consumable electrode melted ingots was by upset or side forging at 2550°F on the Dynapak. Tensile properties were determined over the temperature range of −320 to 3000°F. As-TIG welded sheet specimen of ASTAR-811 and ASTAR-811CN were ductile when bent over a radius of 1t at −320 and −225°F respectively. As-rolled sheet, 33% prior reduction, of both compositions was completely recrystallized after heating for 1 hour at 1600°C. The study of creep properties, phase identification, and effect of heat treatment on phase stability of ASTAR-811 and ASTAR-811CN was initiated. Preliminary results on ASTAR-811CN indicate that only the dimetal carbide is present in the as-cast ingot. (auth)

38523 (N-68-13630) DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY. Quarterly Progress Report, November 20, 1966–February 20, 1967. Buckman, R. W. Jr.; Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS3-2542. 38p. (NASA-CR-72306; WANL-PR-(Q)-014; QPR-13). CFSTI.

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued as the evaluation of Ta−8W−1Re−1 Hf(Astar-811) and Ta−7W−1 Re−1 Hf−0.012C−0.012N (Astar-811CN) sheet material was essentially completed. Tensile properties of TIG welded sheet specimens of both alloys were determined over the temperature range of −320° to 2600°F. One hour post weld anneals at temperatures ranging from 1800° to 2600°F resulted in an increase in the ductile-brittle transition temperature of TIG welded ASTAR-811 CN, while the transition temperature of TIG welded ASTAR-811 remained below −320°F. Phase identification studies on ASTAR-811CN indicated that the hcp tantalum dimetal carbide is the precipitate which occurs during processing to 0.04 inch sheet and short time anneals. The fcc carbonitride phase occurs at the expense of the dimetal carbide during longer (≥16 hours) anneals at temperatures of about 2400°F and higher. The effect of grain size and annealing temperatures on the creep properties of ASTAR-811, ASTAR-811CN, and ASTAR-811C (Ta−8W−1Re−0.7Hf−0.025C). Grain size data were obtained on these alloys as a function of annealing time and temperature were investigated. (auth)

38524 (N-68-18131) DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY. Quarterly Progress Report, February 20–May 20, 1967. Buckman, R. W. Jr.; Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS3-2542. 27p. (NASA-CR-72326; WANL-PR-(Q)-015; QPR-14). CFSTI.

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued as the evaluation of 0.04 inch thick Ta−7W−1Re−1Hf−0.012C−0.012N sheet was essentially completed. Ductile-brittle transition temperatures of tungsten inert gas welded tantalum base alloys were determined as a function of longer post-weld annealing times than previously studied. The results were related to microstructure, phase morphology, and hardness data. Investigation of the effects of grain size on the creep properties of Ta−8W−1Re−1Hf and Ta−8W−1Re−0.7Hf−0.025C was continued. Initial results show that the creep properties of the alloys when recrystallized to 0.03mm grain size were independent of the final annealing-temperature. (auth)

38525 (RFP-1124) SIMPLIFIED METALLOGRAPHIC TECHNIQUE FOR BERYLLIUM. Calabra, Arthur E.; Marts, Don L.; Capes, James F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 12, 1968. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

A simplified metallographic technique for vacuum-cast rolled ingot beryllium sheet and powder pressed beryllium has been developed. This technique is such that the beryllium metallographic specimen needs only to be ground through 600-grit (soft) silicon carbide paper and electrolytically polished. This simplified technique yields polarized light delineation of the microstructure; however, inclusions are not retained. A more precise technique, is described for the preparation of high quality metallography of powder pressed material. (auth)

38526 FABRICATION OF TITANIUM, TANTALUM, AND ZIRCONIUM FOR CHEMICAL PLANT. Bayley, K. J.; Kay, V. B. Chem. Process Eng., 49: 79-81(June 1968).

Methods for forming Ti structural members for the chemical industry are briefly discussed as are pulsed arc and plasma arc welding processes. Methods described for Ti are stated to be applicable to Ta and Zr components. (P.G.C.)

38527 STRESS RELIEF AT DUNGENESS 'B'. Tearle, Keith A. Ind. Process Heat., 8: 26-8(May 1968).

The use of a heating operation to relieve stresses set up by welding in large vessels is commonplace, but the bigger the vessel the more complex the operation. A description is given of the stress relieving exercise as applied to the largest pressure vessel, that of the Dungeness B reactor. (auth) (UK)

38528 EXPLOSIVE BONDING: WATCH IT GROW. Iron Age, 200: 65-8(Nov. 16, 1967).

Explosively clad plate is produced in the form of stainless, Ta and Ti-clad steel. It is used to fabricate pressure vessels for the petrochemical, petroleum, and chemical industries. Research is now concentrated on clad tubing, tubular transition joints, seam welds, lap welds, rib-reinforced structures and spot welds. A hand-held explosive spot welding tool, and a spot welding machine to join Al, Ti, and high-strength steel alloys in thickness from 0.010 to 0.500 in have been constructed. Explosive spot

welding has succeeded in making joints in 2024, 6061, and 7075 Al; 304 and 347 stainless steel, and Ti–6Al–4V. In the area of dissimilar metals, Al has been spot welded to Ti and to stainless, stainless has been joined to Ti, Co-base, and Ni-base alloys. The following materials have been explosively bonded to 1004 through 1020 low C steels; ferritic stainless, 300 and 400 series stainless, ductile and malleable iron, Al and its alloys, Cu, brass, cupronickel, Ni, Inconel, Udimet 700, Ta, Ag, Mo, Mg, Zn, Nb, and Ti. (Metal Abstr.)

38529 SOME EFFECTS OF OXYGEN ON THE TENSILE DEFORMATION OF POLYCRYSTALLINE ZIRCONIUM. Baldwin, D. H.; Reed-Hill, R. E. (Univ. of Florida, Gainesville). Trans. Met. Soc. AIME, 242: 661-9(Apr. 1968).

Six compositions of polycrystalline Zr-O alloys, containing up to 4.2 at.% O, were tested in tension between 77 and 600°K. The data obtained from each of the compositions corresponded closely to a relation between yield stress and absolute temperature of the form $\ln \sigma/\sigma_0 = BT$, where σ_0 is the yield stress extrapolated to zero degrees and B is a constant. In agreement with others who have observed this relationship, it is shown that the activation energy may be expressed as $H_0 \ln \sigma_0/\sigma$. In the present specimens H_0 is approximately 18,000 cal per mole and is apparently independent of temperature and composition inside the limits of the investigation. It is also demonstrated that this form of activation energy corresponds to a strain rate sensitivity parameter RT/H_0. Oxygen was also noted to have an effect upon the operative deformation mechanisms. With increasing oxygen concentration there was an increased tendency to observe both nonbasal slip and cross-slip phenomena. Oxygen does not seriously inhibit twinning more than it does slip. Twins were observed in all specimens tested. (auth)

38530 HOT PRESSING OF $Cb_3Sn(Nb_3Sn)$ AND Cb_3Sn COMPOSITES AND SOME RESULTING SUPERCONDUCTIVE PROPERTIES. Sahm, P. R. (RCA Labs., Princeton, N. J.); Pruss, T. V.; Gandolfo, D. A. Trans. Met. Soc. AIME, 242: 603-7 (Apr. 1968).

Nb_3Sn powders were hot-pressed to establish densification conditions and assess the possible use of such compacts in multiphase structures with ceramic or magnetic inclusions. Superconducting transition temperatures, T_c, were measured as a function of powder particle size, pressing temperature, and second-phase admixtures. The highest transition temperatures were found in coarse powder (5 to 500 μ) compacts and were only weakly dependent on pressing temperatures up to 1200°C. Fine powders (below 5 μ), however, both single-phase Nb_3Sn and Nb_3Sn-composites, showed a stronger dependence on hot-pressing temperatures. While Al_2O_3 phase admixtures did not affect T_c much more, a pronounced T_c degradation was observed upon the addition of ferrimagnetic $Fe_2Mn_{0.5}Zn_{0.5}O_4$ powders. Likewise, critical current densities, J_c, at 4.2°K were lowered appreciably in the ferrite doped samples, whereas the neutral Al_2O_3 inclusions gave slightly improved J_c values. (auth)

38531 ELABORATION OF PURE METALS AND OF COMPOUNDS BY REDUCTION OF HALIDES BY HYDROGEN. Van den Steen, A.; Durand, R. (Laboratoire de Recherches, Brignoud, France). Rev. Met. (Paris), 65: 219-26(Mar. 1968). (In French).

Experiments are described for the purification of Nb from its chloride by reduction with H_2, with possible application to Ta, and in the presence of Th and U. A single fusion in an electron-bombardment furnace allows the formation of an ingot of metal with low interstitial content, starting from a pressed powder. The procedure can be used for very fine (<0.1μ) powders of metals usable in metallurgy or in chemistry as catalysts; of alloys of great homogeneity; of refractory compounds suitable for fritting or dispersing. There can be pollution problems with the technique. The treatment of a mixture of UO_2 and $NbCl_5$ in a weight ratio of 10 gave sufficient heating of the UO_2 powder so that it could be recovered from a film of metal and with very low Cl content. The application of the technique for extraction of Nb is reviewed in light of the principal minerals of Nb. (BBB)

Properties Evaluations

Refer also to abstracts 37775, 37955, 38618, and 39169.

38532 (ANL-Trans-594) STRESS RUPTURE AND CREEP BEHAVIOR OF AUSTENITIC Cr–Ni STEELS IN THE PRESENCE OF Na. Boehm, H.; Schneider, H. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from J. Nucl. Mater., 24: 188-97(1967). 14p. Dep. CFSTI.

A study was made on the influence of liquid sodium on the creep- and stress-rupture properties of two austenitic steels at 700°C. The tests were carried out on sodium filled tubes of X8CrNiMoVNb 1613 and Incoloy 800 under uniaxial stress. (auth)

38533 (GA-8574) CESIUM SORPTION IN MATERIALS FOR THERMIONIC CONVERTERS. Yates, M. K.; Fitzpatrick, G. O. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 8, 1968. Contract AT(04-3)-167. 54p. Dep. CFSTI.

Cesium sorption in materials which could serve as integral reservoirs in thermionic converters was investigated. Samples of integral reservoir materials were received and characterized as to their purity, BET surface area, and pore spectrum. Five samples from the carbon, graphite, porous tungsten, and porous alumina groups considered were selected and loaded with cesium over a range of 600 to 1000°C sample temperature, 0.1 to 30 torr cesium vapor pressure, and 0 to 1000 mg Cs/gram sample cesium loading. In addition, the cesium loadings of five porous tungsten samples were measured at 800°C and 10 torr cesium vapor pressure. The conclusions of these tests were that the cesium sorption in the Al_2O_3, tungsten and carbon samples tested depended primarily on adsorption. Cesium loadings at 800°C and 10 torr were 0.4 mg Cs/g Al_2O_3, 0.06 mg Cs/g W, and 500 mg Cs/g carbon. The cesium loadings in these materials were in general agreement with their BET surface areas. The cesium loading in a W-10 wt % Ta sample was 2.1 mg Cs/gm at 800°C and 10 torr. This loading was approximately 100 times that expected from surface area considerations, but these results were shown to be at least partly due to cesium sorption in the tantalum. The cesium sorption in the graphite samples tested depended primarily upon compound formation and was in general agreement with earlier work. At 800°C and 10 torr, cesium loadings of 400 mg Cs/gm were formed. No significant changes in the cesium loading characteristics of any of the materials tested were observed over the duration of the tests, which lasted from 100 to 1200 hours. However, at the conclusion of the testing it was discovered that the carbon sample had crumbled and that both graphite samples had delaminated. The maximum loadings achieved in these three samples were approximately lg Cs/g C. (auth)

38534 (LA-3894) CHARACTERIZATION OF COMMERCIAL REFRACTORY METAL AND METAL CARBIDE POWDERS. Riley, R. E.; Magnuson, J. E. (Los Alamos Scientific Lab., N. Mex.). Jan. 26, 1968. Contract W-7405-eng-36. 22p. Dep. CFSTI.

A variety of morphological types of structures are obtainable as a result of the manufacturing processes employed and more than one type of structure can result from the same manufacturing process. Four basic morphological types of structures have been identified for the powders examined, and their influence on final properties have been evaluated. The development work described resulted in a breakthrough for better understanding of the practical application of powder characterization data. Significant to this work is the fact that, with the aid of morphology, a procurement specification for a powder to meet a particular requirement can be established. (auth)

38535 (N-68-11650) DETERMINATION OF BIAXIAL CREEP STRENGTH OF T-111 TANTALUM ALLOY. Semiannual Report, March 8–September 8, 1967. Engel, L. B. Jr. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Contract NAS3-9437. 31p. (NASA-CR-72337). CFSTI.

The creep behavior of seamless and welded and reworked T-111 alloy tubing under a biaxial state of stress, and the effects of stress on the corrosion behavior of T-111 alloy by potassium are investigated. Minor design changes in the test facility were completed. The design of the potassium pressure transducer, to be used in measuring the potassium pressure in the refluxing capsules during testing, was completed. Components of the pressure transducer were machined and its assembly is underway. An error analysis was made of the test facility and the stress-strain relationships used in calculating equivalent uniaxial values from biaxial data. (STAR)

38536 (N-68-17317) EFFECTS OF COMPOSITION AND HEAT TREATMENT ON HIGH-TEMPERATURE STRENGTH OF ARC-MELTED TUNGSTEN–HAFNIUM–CARBON ALLOYS. Rubenstein, L. S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 31p. (NASA-TN-D-4379). CFSTI.

The effects of composition, heat treatments, and substructure on the strength and ductility of tungsten–hafnium–carbon (W–Hf–C) alloys were studied. The compositions ranged from 0.23 to 1.76 at.% for hafnium and from 0.179 to 0.942 at.% for carbon, with carbon to hafnium ratios from 0.17 to 2.80 and calculated amounts of hafnium carbide ranging up to 1.5 volume percent. The high-temperature tensile strengths of swaged, recrystallized, solution-annealed and aged alloys increased with increasing hafnium carbide contents up to approximately 0.5 volume percent, after which further additions caused a slight decrease in strength. The strongest alloys contained equiatomic amounts of carbon and hafnium. The

3500°F tensile strength for swaged material was linearly related to the inverse square root of the cell size. Limited tensile and microstructural studies indicated that the W–Hf–C alloys are heat treatable. The stress for a 3500°F 100-hour rupture life was approximately 14,000 psi (96.5×10^6 N/m^2) in the swaged condition. A solution-annealed and aged specimen tested in 3500°F step-load creep tests required a stress of approximately 20,000 psi (138×10^6 N/m^2) for a minimum creep rate of 6×10^{-7} sec^{-1}, corresponding to an approximate 100-hour rupture life. These W–Hf–C alloys exhibit a sevenfold strength improvement over unalloyed tungsten at 3500°F that is related to the precipitation stabilized, fine dislocation structure formed within the cell boundaries. For high strength applications at 3500°F compositions composed of equiatomic amounts of carbon and hafnium, approximately 0.3 to 0.4 at.% are recommended. (auth)

38537 (N–68–17372) GENERATION OF LONG TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Final Report, June 26, 1963–February 15, 1967. Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio. Materials Research and Development Dept.). June 6, 1967. Contract NAS3-2545. 197p. (NASA-CR-93193; ER-7203). CFSTI.

Creep tests were conducted on selected refractory alloys in a vacuum environment ($<1 \times 10^{-9}$ torr) for times between 100 and 15,000 hours. Since the ultimate program goal was to provide design data for space electric power systems, emphasis was placed on measuring creep extension below 1%. The resulting data were evaluated in terms of the relative properties of niobium, molybdenum, tantalum, and tungsten-base alloys. Larson-Miller and Manson-Haferd techniques were used to present the data in parametric form in the 1800°F to 2200°F temperature range, the molybdenum-base alloys TZC and TZM possess the best creep properties for the potential turbine applications. The variability of the creep properties as a function of heat of material was determined for the T-111 alloy. In addition to comparison of alloy creep properties, chemical analysis, metallography, and tensile test data are presented to characterize each of the materials before and after creep testing. (auth)

38538 (N–68–18145) DEVELOPMENT OF A COBALT–TUNGSTEN FERROMAGNETIC, HIGH-TEMPERATURE, STRUCTURAL ALLOY. Ashbrook, Richard L.; Hoffman, Anthony C.; Sandrock, Gary D.; Dreshfield, Robert L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 44p. (NASA-TN-D-4338). CFSTI.

Rotors for space power generators require a compromise between high-temperature strength and magnetic properties. Rotors must withstand high centrifugal stresses at high temperature and develop high induction for small exciting fields. Alloys considered for rotors include maraging steels, H-11 steel, and a cobalt-base alloy, Nivco. Work to develop alloys with improved high-temperature strengh and good high-temperature magnetic properties is described. Because cobalt has the highest Curie temperature of any metal and is a good base for high-temperature alloys, a superalloy, cobalt-25 tungsten-1 titanium-½ zirconium-½ carbon was chosen for further study. Modifications of this alloy were screened for maximum magnetic induction B_{max} at a maximum magnetizing force H_{max} of 100 oersteds (7958 A/m) over a range of temperatures. Below 1000°F, low tungsten alloys show inflections in a plot of B_{max} as a function of temperature due to the instability of the face-centered cubic (fcc) phase. Stability of the fcc increased with increasing tungsten and iron. A preferred alloy, Co–7-1/2W–2-1/2Fe–1Ti–1/2Zr–1/2C, was evaluated for magnetic and mechanical properties in cast form and for mechanical properties as sheet. After aging at 1700°F for 72 hours, this alloy had a coercive force of 10.5 oersteds (835 A/m) at 75°F and a B_{max} of 11.5 and 10.3 kilogauss (1.15 and 1.03 T) at 1200° and 1400°F, respectively. The stress-rupture life at 1200 to 1400°F was greater than that of the strongest high-temperature commercially available magnetic-structural alloy. (auth)

38539 (ORNL-TR-1797) THERMODYNAMIC CALCULATION OF THE DISTRIBUTION COEFFICIENT BETWEEN THE LIQUID AND SOLID PHASES OF AN ELEMENT IN DILUTE SOLUTION IN A METAL: APPLICATION TO THE PURIFICATION OF BERYLLIUM. Desre, P.; Schaub, B.; Bonnier, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from pp 493-500 of STI/PUB-109(Vol.1) presented at IAEA Symposium on Thermodynamics, Vienna, 1965. 7p. (CONF-650704–37). Dep. CFSTI.

This report was abstracted from the original language and appeared in NSA as 20: 23229. (R.C.K.)

38540 (UCRL-50314) DIFFUSION OF IRON IN VARIOUS FERROUS ALLOYS. Lai, D. Y. F.; Borg, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1967. 6p. Dep. CFSTI.

The effect of various solutes upon the self diffusion of Fe was measured using a sectioning technique with ^{59}Fe as a tracer. Autoradiographs taken at various depths during the sectioning established absence of severe grain boundary diffusion. All alloys except Fe–V and Fe–Al exhibited extreme intergranular fracture which was eliminated by hot rolling and re-annealing. Results of diffusion measurements for Fe in Al, Ge, Si, Sm, Sb, Sn, Ti, and V are tabulated. (P.G.C.)

38541 THE CREEP-RUPTURE PROPERTIES OF SOME REFRACTORY METAL ALLOYS. I. EFFECT OF HEAT TREATMENT ON THE PROPERTIES OF THE NIOBIUM-BASE ALLOY D-43. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 15: 395-402(Aug. 1968).

The creep rupture properties of D-43 alloy (Nb-10% W-1% Zr-0.1% C) heat-treated according to the revised commercial fabrication schedule involving temperatures >1204°C were investigated along with those of recrystallized material. Material in both of these conditions was stronger at long times and high temperatures than D-43 which had been fabricated at temperatures ≤1204°C. Dramatic improvements due to the higher heat-treating temperature were apparent from short-time data at 982°C, but these were not stable for long times. Materials exposed to high temperatures (1538°C) can actually be weaker at short times after holding 500 hr at 982°C prior to loading. (auth)

38542 THE CREEP-RUPTURE PROPERTIES OF SOME REFRACTORY METAL ALLOYS. II. THE PROPERTIES OF THE NIOBIUM-BASE ALLOYS FS-85 AND Cb-752 AND THEIR RESPONSE TO HEAT TREATMENT. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 15: 403-14(Aug. 1968).

The creep rupture properties of FS-85 (Nb-27% Ta-10% W-1% Zr) and Cb-752 (Nb-10% W-2.5% Zr) have been studied at 982°C (1800°F), 1204°C and 1427°C for times from 10 to 1000 hr. It was found that the properties of each of these alloys can be improved by annealing 1 hr at 1593°C prior to testing. These improvements were stable for at least 1000 hr. Pretest annealing at higher temperatures yielded inferior properties. (auth)

38543 THE CREEP-RUPTURE PROPERTIES OF SOME REFRACTORY METAL ALLOYS. III. COMPARATIVE MECHANICAL BEHAVIOR OF SOME TANTALUM-BASE ALLOYS. Stephenson, R. L.; McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 15: 415-24(Aug. 1968).

The creep rupture properties of unalloyed tantalum, Ta-10% W, T-III (Ta-8% W-2% Hf), and T-222 (Ta-9.6% W-2.4% Hf-0.01% C) have been evaluated over the temperature range of 1000 to 1650°C. The tantalum-base alloys exhibited equivalent properties over the entire temperature range. Although precipitates form in these materials, the primary strengthening mechanism is thought to be solid-solution hardening. (auth)

38544 MECHANICAL RELAXATIONS IN POLYCRYSTALLINE MOLYBDENUM, TANTALUM, AND IRIDIUM AT HIGH TEMPERATURES AND LOW FREQUENCIES. Murray, M. J. (Cambridge Univ., Eng.). J. Less-Common Metals, 15: 425-35(Aug. 1968).

An inverted torsion pendulum with a period of about 1 cps has been developed to study internal friction, dynamic modulus, and creep of refractory metals at temperatures up to 2000°C. Studies have been made on polycrystalline and monocrystalline specimens of Mo, Ta, and Ir and peaks in the internal friction have been observed above 1000°C in all the polycrystalline specimens. Each relaxation has an associated measured activation energy apparently near to the activation energy for self diffusion. The corresponding relaxation strengths for Ir and Ta were very large and similar in magnitude, while that for Mo was an order of magnitude smaller. The peaks were absent or greatly reduced in single crystals and large grained specimens, and it was concluded that the relaxations are of the grain boundary type. (auth)

38545 SUPERCONDUCTING TRANSITION TEMPERATURES OF ZIRCONIUM–NIOBIUM ALLOYS. Corsan, J. M.; Williams, I.; Catterall, J. A.; Cook, A. J. (National Physical Lab., Teddington, Eng.). J. Less-Common Metals, 15: 437-43(Aug. 1968).

Measurements of the superconducting transition temperature, T_c, upper critical field and normal state resistivity, have been carried out on a wide range of Zr–Nb alloys heat treated at 585°C. An extremely rapid rise in transition temperature, from 0.7 to 3.5°K, has been observed in the α-Zr solid solution region (0%–1.25% Nb) which lends support to a recent theoretical model for the density of states of ^{9}Zr. The transition temperature continues to increase in the early part of the two-phase region, reaching a value of 10°K at 6% Nb. The precise value of T_c, in fact, depends on the distribution of the β-precipitate for compositions between 1.25% and 6% Nb. Thereafter T_c remains approximately constant with composition up to the β-solid-solubility boundary at 88% Nb. The upper critical field and the normal state resistivity show

maxima at 75% Nb, which are discussed in terms of the microstructure. (auth)

38546 PHASE-EQUILIBRIUM DIAGRAM OF $Al_2O_3-ZrO_2$ AND EXAMINATION OF A NEW PHASE 99 PERCENT Al_2O_3–1 PERCENT $ZrO_2(\epsilon-Al_2O_3)$. Cevales, G. (Montecatini-Edison S.p.A. Porto Marghera, Venice). Ber. Deut. Keram. Ges., 45: 216-19 (May 1968). (In German).

The phase-equilibrium diagram of $Al_2O_3-ZrO_2$ has been restudied and its liquid curve has been determined. It deals with a system of the type of 2 components which do not mix in the solid state and forming an eutectic. This last has a composition 57.4% Al_2O_3, 42.6% ZrO_2 and a melting point of 1710 ± 10°C. On the side of the alumina a little solubility of ZrO_2 in Al_2O_3 has become evident through quenching with the formation of a new phase clearly distinguishable from the α-one. The name of $\epsilon-Al_2O_3$ is proposed for this new modification. Its field of stability is above 1930°C, while at a lower temperature $\alpha-Al_2O_3$ is being reformed with separation of ZrO_2. The structural examination of $\epsilon-Al_2O_3$ has been made both on the base of diffractograms of powder of the material fused to the arc and quenched, and with x-ray at 1950°C using a chamber for high temperatures. The structure of $\epsilon-Al_2O_3$ is of hexagonal type. The parameters (hkl) and the constants of the lattice $a_0 = 7.849$ and $c_0 = 16.183$ were determined. The solubility of Al_2O_3 in ZrO_2— as it is known— is greater on the side of ZrO_2. However, since this fact is directly tied with the more general problem of the stabilization of the tetragonal ZrO_2, the argument is expressly omitted. (auth)

38547 DIFFUSION OF ZIRCONIUM, MOLYBDENUM, AND NIOBIUM IN METALLIC YTTRIUM AT TEMPERATURES OF 1000 TO 1300°C. Rogozin, V. D.; Gert, L. M.; Babad-Zakhryapin, A. A. Izv. Akad. Nauk SSSR, Metal., No. 3, 228-31(May-June 1968). (In Russian).

For the mutual diffusion in the Y–Zr system in the temperature interval from 1000 to 1300°C, the following temperature dependence of the diffusion coefficient was obtained: $D = 4 \times 10^{-4} \exp(-38000/RT)$. At the temperature of 1300°C the maximum possible values of the diffusion coefficients of Mo and Nb in Y were determined as $D_{Mo\to Y} \leq 1.8 \times 10^{-6}$ cm²/sec and $D_{Nb\to Y} \leq 1.4 \times 10^{-6}$ cm²/sec. (tr-auth)

38548 CRITICAL CURRENTS OF SOME SUPERCONDUCTING ALLOYS OF THE Nb–Zr–Ti SYSTEM. Grigor'ev, A. M.; Lainer, D. I.; Pakhomov, V. Ya.; Raevskaya, M. V.; Sokolovskaya, E. M. Izv. Akad. Nauk SSSR, Metal., No. 3, 215-18(May-June 1968). (In Russian).

The polythermal cross section of the Nb–Zr–Ti system with constant content of 20 at.% Ti, 20 at.% Zr, or 50 at.% Nb was constructed, and some physical properties of the alloys of this cross section such as the critical current density in the superconducting state and hardness were investigated. The critical current density of cold-deformed samples, obtained from cast material and having the structure of ternary β solid solutions, is altered slightly with change of the composition. The critical current density of the cold-deformed samples studied of the Nb–Zr–Ti system in a magnetic field of 17 kOe is lower than in Nb–25% Zr alloys. (tr-auth)

38549 EFFECT OF NEODYMIUM, YTTRIUM, AND HAFNIUM ON THE HARDNESS AND MICROSTRUCTURE OF CHROMIUM. Myasnikov, V. V.; Morozov, V. A.; Matveeva, M. P. Izv. Akad. Nauk SSSR, Metal., No. 3, 188-91(May-June 1968). (In Russian).

The effect of the addition of hafnium (0.1 to 30 at.%), yttrium (0.10 to 3 at.%), and neodymium (0.10 to 3 at.%) on the hardness, "hot hardness," creep at increased temperature, and microstructure of chromium alloys was studied. Addition of 0.10 to 0.25 at.% Y or Nd leads to significant reduction of the hardness of chromium at room temperature and an increase of the ductility at increased temperature. Increase of the content of neodymium and yttrium above 0.5 at.% does not lead to a further increase of the ductility, since the surplus phase being formed, dispersed in the form of particles within the grain and situated at the boundaries, indicates a hardening effect and inhibits the course of the process of plastic deformation. Alloys containing hafnium have an increased brittleness. In spite of the fact that additions of hafnium in quantities of 0.1 to 0.25 at.% somewhat reduces the hardness at room temperature, the brittleness of chromium increases. Addition of hafnium in quantities of 0.5 to 3 at.% leads to increase of the heat resistant properties, evaluated by the method of hot hardness, and to creep. Electron microscopy showed the presence of hardening phases, apparently, of the intermetallic type, stable at high temperatures. Investigation of creep by the constant hardness method at 1050°C showed that the effects of hafnium, yttrium, and neodymium on the creep rate are dissimilar. Hafnium to the extent of the increase of the chromium content reduces the creep rate; yttrium and neodymium sharply increases the creep rate of chromium at concentrations up to 3%, additions of neodymium of 0.25 at.% increase the creep rate to a greater degree than the introduction of yttrium. (tr-auth)

38550 INVESTIGATION OF THE CREEP OF NIOBIUM IN THE TEMPERATURE INTERVAL FROM 900 TO 1900°C. Prokoshkin, D. A.; Vasil'eva, E. V.; Popov, N. N. Izv. Akad. Nauk SSSR, Metal., No. 3, 182-7(May-June 1968). (In Russian).

Investigations were made of the creep of niobium by tension and torsion methods in a vacuum in the temperature interval from 0.47 to 0.88 T_{fusion}°K (900 to 1900°C). In the temperature region close to 0.5 T_{fusion}°K, the activation energy for the establishment of creep depends on the temperature and applied stress and changes for cases of the study of the creep with tension from 85 kcal/mole at 30 kg/mm² to 105 kcal/mole at 3 kg/mm², and for torsion up to 110 kcal/mole at 0.139 to 0.841 kg/mm². Above 0.5 T_{fusion}°K the activation energy for the establishment of creep practically does not depend on the applied stress and occurs at the level close to the value of the activation energy of the volume self-diffusion both with tension and with torsion. The creep rate depends on the applied stress. The high-temperature creep of niobium is controlled basically by the diffusion process. Below 0.5 T_{fusion}°K the mechanism of creep is additive and is controlled equally by the diffusion, displacement, and other processes, each of which has its own activation energy. (tr-auth)

38551 INVESTIGATION OF SOME PHYSICOCHEMICAL PROPERTIES OF ALLOYS OF THE Nb–W–Mo–Ti SYSTEM. Pryakhina, L. I.; Ozhimkova, O. V. Izv. Akad. Nauk SSSR, Metal., No. 3, 204-9(May-June 1968). (In Russian).

The microstructure of some Nb–W–Mo–Ti alloys (from 60 to 100% Nb) was investigated after tempering at 1200°C. The alloys have the structure of solid solutions. The specific electroresistance and hardness of some alloys of the Nb–W–Mo–Ti system (from 60 to 100% Nb) was investigated. It was established that an increase of the content of W, Mo, and Ti in the alloy up to 40 wt % significantly increases the specified properties. The hot hardness of the alloys of the system Nb–W–Mo–Ti (from 60 to 100% Nb) was investigated in the temperature interval from 20 to 1100°C. A sharp increase of the hardness with increase of the W, Mo, and Ti in the alloys was observed in low-temperature tests (from 20 to 500°C). At high test temperatures, near 1000 to 1100°C, the effect of the hardening of the Nb-base alloys during their alloying with W, Mo, and Ti was shown to a lesser degree. The thermal stability of alloys of the Nb–W–Mo–Ti system (from 60 to 100% Nb) was investigated at 1000°C. It was established that alloys of the radial cross section with ratio of the sum of W and Mo to Ti equal to 1 : 1 have the greatest thermal stability. The introduction of W, Mo, and Ti (in exact quantities) to Nb alloys increases their resistance to oxidation approximately 7 to 12 times. (tr-auth)

38552 SOME PROPERTIES OF TUNGSTEN AND TUNGSTEN-BASE ALLOYS. Borok, B. A.; Dzneladze, Zh. I.; Ershova, I. O. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 54-8(May 1968). (In Russian).

The effects of alloying additives of hafnium and lanthanum (0.25% by volume) on tungsten properties such as temperature of the beginning of recrystallization, temperature of tungsten transition from brittle state to plastic state, and strength characteristics at elevated temperatures are reported. It is established that hafnium addition increases the temperature of the beginning of tungsten recrystallization from 1200 to 1300°C; alloying tungsten with lanthanum does not increase it. Tungsten alloying with hafnium affects positively the mechanical properties of tungsten. (auth)

38553 INVESTIGATION OF DURABILITY NATURE OF TUNGSTEN–NICKEL–IRON ALLOY. COMMUNICATION I. Minakova, R. V.; Pilyankevich, A. N.; Teodorovich, O. K.; Frantsevich, I. N. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 73-8(May 1968). (In Russian).

The results of investigating the process of aging of tungsten–nickel–iron alloys under conditions of slow cooling from the sintering temperature are reported. It is shown that aging occurs in a surface layer of the grains in refractory phase and in the body of fusible alloy-bonds. The mechanism of alloy aging was studied by means of electronic-microscopic fractography. (auth)

38554 VISCOSITY OF THE ALKALI METAL VAPORS. Lee, D. I.; Bonilla, C. F. (Columbia Univ., N. Y.). Nucl. Eng. Design, 7: 455-69(1968).

The viscosities of cesium, rubidium, potassium, and sodium vapors were measured up to 1000°C in the pressure range from 0.4 to 5 atm by a steady flow high-temperature coiled capillary viscometer. The interaction potential energies for the singlet and triplet states of alkali metal atoms were obtained from those of

hydrogen atoms by a semiempirical scaling procedure based on the repulsive-core theory, and those for the dimer-dimer, and monomer-dimer interactions were also calculated from those for the triplet states by a semiempirical pairing procedure. The Chapman-Enskog method was used for the calculation of the viscosity of the alkali metal monatomic and diatomic vapors, and the viscosity of the equilibrium frozen-state vapors was also calculated, either by a rigorous combination method or by Wilke's method. There was good agreement between values extrapolated from the experimental results and the calculated values of the viscosity of the alkali metal monatomic vapors, but those of the equilibrium vapors differ from the calculated values. This suggests that the Chapman-Enskog method may not be applicable to the viscosity of chemically associating gases. (auth)

38555 SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. II. TITANIUM, VANADIUM, CHROMIUM, MANGANESE, ZIRCONIUM, NIOBIUM, MOLYBDENUM, AND THULIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Nucl. Mater., 27: 181-6(Aug. 1968). (LA-DC-9435).

The solubilities of Ti, V, Cr, Mn, Zr, Nb, Mo, and Tm in liquid Pu were measured individually over the temperature range 700 to 1000°C. At 700°C the atomic fractions are 0.0544 Ti, 0.0102 V, 0.0162 Cr, 0.0210 Zr, 0.0110 Nb, 0.0157 Mo, and 0.0235 Tm. The solubilities increase to 0.372 Ti, 0.0446 V, 0.0858 Cr, 0.0371 Nb, and 0.0848 Tm at 1000°C. At 850°C, the atomic fraction of Mn is 0.308, and at 950°C the atomic fraction solubilities of Mn, Zr, and Mo are 0.457, 0.180, and 0.0458, respectively. The data fit empirical equations of the form $\log_{10} N_i = A - (B/T)$, where N_i is the solubility of the element i expressed as the atomic fraction and T is the temperature in °K. (auth)

38556 NUCLEATION OF BRITTLE FRACTURE IN SINTERED TUNGSTEN AT LOW TEMPERATURES. Bilello, John C. (General Telephone and Electronics Labs., Bayside, N. Y.). Trans. Met. Soc. AIME, 242: 703-8(Apr. 1968).

The brittle fracture behavior of cold-worked sintered tungsten was studied over the temperature range 4.2 to 298°K using a high-sensitivity strain measuring system and electronfractography. Similar observations were made on a swaged electron beam zone-refined monocrystal. In sintered tungsten irreversible plastic deformation was observed during cyclic load-unload tests at stress levels well below the fracture stress for all temperatures, but general microyielding could be detected only down to 202°K. For the zone-refined samples macroyielding occurred at all test temperatures with evidence for twinning below ~202°K. The fracture stress of the sintered tungsten was virtually independent of temperature, while the zone-refined crystal showed a 2.3 times increase over the same temperature range. Electronfractography confirmed the presence of numerous rod-shaped and spherical submicroscopic voids which ranged in diameter from 1400 to 4300 Å in the sintered tungsten; no voids could be found in the zone-refined tungsten. Contrast effects observed on the replicas in the vicinity of certain voids indicated that plastic deformation could be induced by the local stress concentration. It has been suggested that the presence of these voids may be responsible for the low-temperature brittle failure of sintered tungsten. Based on this suggestion and on the evidence obtained here, a dislocation model is presented to account for the brittle behavior of sintered tungsten. In this model, slip, which is induced by the local high stress concentration in the region at the edge of a favorably oriented void, could cause the void to grow to a microcrack of critical size. (auth)

38557 PLASTIC DEFORMATION OF METALS. Honeycombe, R. W. K. London, Edward Arnold, 1968. 491p. 90s.

The subject is discussed under the following chapter headings: Introduction; deformation of metal crystals; elementary dislocation theory; theories of work hardening of metals; solid solutions; deformation of crystals containing a second phase; other deformation processes in crystals; deformation of aggregates; formation of point defects in metals (including formation by irradiation, structural studies on irradiated metals, and effect of irradiation on mechanical properties); annealing of deformed metals; anisotropy in polycrystalline metals; creep in pure metals and alloys; fatigue; and fracture. (UK)

38558 PERMEABILITY OF TUNGSTEN TO NITROGEN FROM 1800 TO 2600°C. Conn, P. K.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati). Trans. Met. Soc. AIME, 242: 626-30(Apr. 1968).

Permeation rates for nitrogen through arc-cast tungsten were measured in the temperature range 1800°to 2600°C at nitrogen pressure differentials of 1.0 and 0.1 atm. Gas chromatography was used to measure the quantities of nitrogen which permeated through the 0.26- and 0.53-mm-thick membranes. Permeation rates were proportional to the difference between the square roots of the nitrogen pressure on each side of the membrane and inversely proportional to membrane thickness, indicating that atomic nitrogen was the diffusing species and that diffusion was the rate-limiting step of the process. Permeation coefficients calculated from the rates may be represented by the equation: $P = 277 \exp(-70.0 \pm 0.8/RT)$ where P is expressed in the units cu cm (STP)-mm per sq cm-min-atm$^{\frac{1}{2}}$ and 70.0 ± 0.8 is the activation energy in kcal per mole of permeating species. (auth)

38559 MICROHARDNESS AND MICROHARDNESS ANISOTROPY OF TUNGSTEN. Rieck, G. D.; Vaessen, G. H. G.; Vogel, D. L. (Technological Univ., Eindhoven, Netherlands). Trans. Met. Soc. AIME, 242: 575-8(Apr. 1968).

Microhardness anistropy of powder metallurgical, electron-beam melted, polycrystalline, single-crystal, and recrystallized W was measured. Knoop hardness of undoped single-crystal W varied with direction of testing in {001} as well as in {110} planes. The {111} planes showed little variation in hardness. (P.G.C.)

38560 DISCUSSION OF "DIFFUSION CREEP IN ZIRCONIUM AND CERTAIN ZIRCONIUM ALLOYS". Woodford, D. A. (General Electric Co., Schenectady, N. Y.). Trans. Met. Soc. AIME, 242: 744-5(Apr. 1968).

Discussions and criticisms of theories and equations used in a previously published paper, to explain the mechanisms of diffusion creep in Zr and Zr alloys are presented. (P.G.C.)

38561 THERMAL AND ELECTRICAL RESISTIVITIES OF RHENIUM FROM 2°K TO 20°K. Schriempf, J. T. (Naval Research Lab., Washington, D. C.). J. Phys. Chem. Solids, 28: 2581-7(Dec. 1967).

Measurements of the thermal and electrical resistivities of highly pure monocrystals of rhenium were made at 2 to 20°K. The ideal resistivities can be described by $\rho_i \propto T^m$ (in the electrical case) and by $\omega_i \propto T^n$ (in the thermal case) only if m and n are allowed to vary with temperature. The values of m and n fall smoothly from 5.1 and 3.3 at 20°K and become 2 and 1, respectively, at the lowest temperatures. The anisotropy at all temperatures is found to be approximately $\rho_{i\perp}/\rho_{i\parallel} \sim 1.3$ and $\omega_{i\perp}/\omega_{i\parallel} \sim 1.1$, where the parallel orientation is along the c axis of the hexagonal-close-packed lattice of rhenium. Below about 11°K the ideal resistivities obey a Wiedemann–Franz law, with a Lorenz number of roughly 0.5×10^{-8} V^2/deg^2. (auth) (UK)

Structure and Phase Studies

Refer also to abstract 39169.

38562 (KFK-692) PHYSIKOCHEMISCHE BEITRAEGE ZUR METALLKUNDLICHEN ANALYSE. (Physicochemical Report on Metallurgical Analysis). Sundermann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Apr. 1968. 78p. (In German). Dep.

The fundamentals of methods of operation and technical developments in phase exposure and phase separation from metallic materials for analytical metallurgical studies of reactions in alloys are reported. A review is given of the potentiostatic electrolysis for phase isolation from steels. The effects of electrolytes, the alloying elements, and heat treatment on the current density potential curve or on the decomposition potential of the metallic matrix and its structural constituents are shown. An electronic potentiostat was developed for carrying out the electrolysis. The potential distribution for special electrode systems was calculated for estimation of the geometric effects on the electrolytic attack. The separation of phases was then considered. The theory of repulsive effect between dipoles and a periodic magnetic field under the effect of dipole hysteresis was developed. The development of a magnetic separation method is described. Separations carried out show the separation sharpness attainable. (tr-auth)

38563 (N-68-11803) AN X-RAY STUDY OF LOCAL ATOMIC ARRANGEMENTS AND THE EFFECT OF COLD WORK ON SHORT-RANGE ORDER IN A NICKEL–10 ATOMIC PERCENT TUNGSTEN ALLOY. Ammons, Aubrey Mitchell (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). Aug. 1967. 81p. (NASA-CR-90508). CFSTI.

Thesis.

The local atomic arrangements in a nickel-10 at.% tungsten alloy and the effects of cold work on the degree of short-range order in the alloy was studied. A single crystal was oriented to permit x-ray diffuse scattering measurements. Comparison of the experimental α_{1mn} with values calculated from models led to the conclusion that the short-range structure of the nickel-10 at.% tungsten alloy is statistically similar to the structure of long-range ordered Ni_4W. The atomic size effect was relatively small; an estimate of the nearest neighbor size effect coefficient gave $\beta_{110} = 0.009 \pm 0.004$, x-ray diffuse scattering measurements were also made on

polycrystalline samples of the nickel alloy as a function of reduction by cold rolling and following recrystallization of recovery treatments. These data showed that cold working decreased the degree of short-range order in the alloy, but there was still some local order remaining after reductions as great as 80%. Most or all of the short-range order destroyed by cold working could be recovered by annealing the samples at temperatures (near 600°C) below that necessary for recrystallization. Cold work and annealing treatments were followed by electrical resistivity measurements. (auth) (STAR)

38564 (NYO-3560-8) POWDER METALLURGY TECHNIQUE FOR THE PREPARATION OF $HoZn_2$ SAMPLES. Michel, David J.; Ryba, Earle (Pennsylvania State Univ., University Park. Dept. of Materials Science). May 23, 1968. Contract AT(30-1)-3560. 9p. Dep. CFSTI.

Equipment and procedures used in preparing compacts of an intermetallic compound, $HoZn_2$, for mechanical properties measurements are described. (P.G.C.)

38565 (NYO-3560-12) THE ELASTIC CONSTANTS OF POLYCRYSTALLINE $HoZn_2$. Michel, D. J.; Ryba, Earle; Chang, Z. P. (Pennsylvania State Univ., University Park). May 23, 1968. Contract AT(30-1)-3560. 8p. Dep. CFSTI.

The elastic constants of polycrystalline $HoZn_2$ were determined in the 90 to 298°K region by ultrasonic techniques. The constants $C_{11} = \rho V_L^2$ and $C_{44} = \rho V_S^2$ vary with temperature in a linear manner and were extrapolated to 0°K by a least-squares fit to the data to give 1.176×10^{12} and 0.334×10^{12} dynes/cm^2, respectively. The Debye Temperature for $HoZn_2$ was calculated to be 247°K, and the bulk modulus of $HoZn_2$ at 298°K is 0.6814×10^{12} dynes/cm^2. (auth)

38566 ON A NEW Mo–Zn INTERMETALLIC COMPOUND. Toussaint, C. J.; Venker, H. (EURATOM-CCR, Ispra, Italy). Acta Crystallogr., Sect. B, 24: 743(1968). (In German).

A new intermetallic compound $MoZn_{\sim 22}$ has been prepared. It has the orthorhombic structure, with the cell constants $a_0 = 6.510 \pm 0.002$, $b_0 = 10.633 \pm 0.002$, $c_0 = 9.205 \pm 0.002$ Å. The x-ray powder pattern is given. (auth) (Denmark)

38567 KINETICS OF BETA-PHASE DECOMPOSITION AND THE PRECIPITATION OF ALPHA–ZIRCONIUM IN Nb–25 AT. PERCENT Zr SUPERCONDUCTING ALLOY. Soeno, Ko; Kuroda, Tetsuro (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 391-6(1968). (In Japanese).

The kinetics of beta-phase decomposition and the precipitation of alpha-zirconium were investigated by measuring the change in electrical resistivity at liquid nitrogen temperature. Studies on the reaction in the miscibility gap region were carried out by rapidly heating the specimens which were previously quenched from 1200°C or cold-worked after the quenching. The kinetics of the decomposition are conveniently described with T–T–T curves extending from 650 to 800°C. It was evident that there was a general acceleration of the decomposition in the cold-worked specimens. For example, the 50% decomposition lines in 25 to 75% cold worked specimens were displaced to about $^1/_{10}$ of that for the specimens quenched from 1200°C. In order to investigate the precipitation of alpha-zirconium, specimens after about 75% beta-phase decomposition, heated at 750°C for 46 hr after 75% cold drawing, were used and the reaction rate was measured between 400 and 500°C. The time required to attain about 95% of the transformation was about 10^3 min at 500°C and about 6×10^3 min at 400°C. The acceleration of the precipitation by cold work are also shown in the specimens cold-worked after the beta-phase decomposition treatment. (auth)

38568 POINT DEFECTS AND DIFFUSION IN STRAINED METALS. Girifalco, L. A.; Welch, D. O. New York, Gordon and Breach, Science Publishers, Inc., 1967. 176p. $6.50 Hardbound, $3.25 Paperbound.

Topics covered include: point defect and diffusion theory, interaction energies and entropies of defects with stress fields, defect concentration and migration in stress fields, and effect of elastic strain gradients on macroscopic diffusion equations. (M.C.G.)

38569 MODELS AND PREDICTION OF [10$\bar{1}$1] TWINNING. Westlake, D. G. (Argonne National Lab., Ill.). Scr. Met., 1: 9-12(1967).

Various atomic models, designed to explain twinning in hcp alloy crystals, are discussed. Aspects considered include the arrangement of atoms around twinning locations, strains, zonal dislocations, occurrence of twins, bond parameters, nucleation, and propagation of twins. (P.G.C.)

38570 BCC STACKING FAULT ENERGIES. Wasilewski, R. J. (E. I. du Pont de Nemours and Co., Wilmington, Del.). Scr. Met., 1: 45-7(1967).

From the formula for the elastic energy of a single crystal under compression the energy per crystal plane is calculated and from this equation the corresponding stacking fault energy is derived. Stacking fault energies for many bcc elements may be calculated directly from single crystal elastic constants. The stacking fault energies for alkali metals are very low as are those for β brass and Au–Cd alloys. In fcc elements comparable elastic strain at the stacking fault is assumed to be due to bond distortion. (P.G.C.)

38571 EFFECT OF THERMAL DIFFUSION ON CONSTITUTIONAL SUPERCOOLING DURING SOLIDIFICATION. Verhoeven, J. D. (Ames Lab., Iowa). Scr. Met., 1: 93-6(1967).

The effects of thermal diffusion on constitutional supercooling of alloys during solidification are reviewed. Equations are given to describe unidirectional mass transport in a binary alloy system, interface flux balances at the interface of a unidirectional solidifying alloy, and for the onset of constitutional supercooling. 9 references. (P.G.C.)

38572 COMMENTS ON INDICES OF PLANES AND DIRECTIONS IN hcp CRYSTALS. Okamoto, P. R.; Thomas, G. (Univ. of California, Berkeley). Scr. Met., 1: 25-8(1967).

The feasibility of constructing a four-axis hexagonal lattice in reciprocal space for interpretation of electron diffraction patterns and images in hcp crystals is postulated. The proposed lattice follows directly from the conventional Miller to Miller–Bravais transformation for polar indices and Miller–Bravais notations may be used for indexing procedures. (P.G.C.)

38573 INTERACTION OF THE COMPOUNDS Nb_3Al AND Mo_3Al. Matveeva, N. M.; Maksimov, Yu. A. Izv. Akad. Nauk SSSR, Metal., No. 3, 210-14(May-June 1968). (In Russian).

By x-ray structure and microstructure analysis methods and by measurement of the changes in hardness in relation to the composition, the formation of continuous solid solutions in the system Nb_3Al–Mo_3Al with crystal structure of the type W_3O was established. The lattice of the solid solution depends linearly on the composition, and the hardness curve has an even character with a broad maximum. The microstructure of the alloys in all intervals of the solid solution concentration represents a homogeneous polyhedron. The temperatures of the transition to the superconducting state (T_k) of the alloys of the system Nb_3Al–Mo_3Al were measured. Above 1.28°K all alloys up to 65 wt % Mo are superconducting. The change of T_k with concentration of Mo in the solid solution has a character close to exponential. The transition temperature is reduced gradually from 16.4°K for pure Nb_3Al to 2.73°K for alloys with 64% Mo. The dependence of T_k on the composition verified the formation between Nb_3Al and Mo_3Al of continuous solid solution with W_3O crystalline structure. (tr-auth)

38574 INVESTIGATION OF THE PHASE COMPOSITION OF ALLOYS OF THE La–Fe–Al SYSTEM. Zarechnyuk, O. S.; Emes-Misenko, E. I.; Ryabov, V. R.; Dikii, I. I. Izv. Akad. Nauk SSSR, Metal., No. 3, 219-21(May-June 1968). (In Russian).

By x-ray structure and microscopic analysis, 101 ternary alloys of the La–Fe–Al system with La content up to 33.3 at.% were investigated. The isothermal cross section of the part of the system studied at 500°C was constructed. It was established that in the La concentration range studied, six compounds were formed: $LaFe_4Al_8$ (Ψ) structure of the $CeMn_4Al_8$ type (superstructure to the $ThMn_{12}$ type), $La_2Fe_{8\to7}Al_{11\to10}$ (ϕ_2)-structure of the Th_2Zn_{17} type, $LaFe_{8\to7}Al_{3\to6}$ (Ω)-structure of the $NaZn_{13}$ type, $LaFe_2Al_{10}$ (Ψ'), $LaFe_2Al_7$ (N_1), and $LaFe_{1\to1.4}Al_{1\to0.6}$. Structures of the N_1 and N_2 phase were not determined. (tr-auth)

38575 STRUCTURAL DIAGRAM OF THE Zr–Cr SYSTEM. Budberg, P. B.; Alisova, S. P.; Musaev, R. S. Izv. Akad. Nauk SSSR, Metal., No. 3, 222-3(May-June 1968). (In Russian).

X-ray and high-temperature contactless thermal analyses were used to investigate the structural diagram of the Zr–Cr system in the interval from 18 to 65% Cr. The alloys were prepared in arc furnaces from iodide zirconium and electrolytic Cr and annealed at 1200°C for 25 hrs and at 1000°C for 100 hrs. Two eutectics were formed in the system: at 1320°C and 18% Cr and at 1580°C and 70% Cr. The peritectic transformation at 1470°C ($\gamma \rightleftharpoons$ liq + δ) and the eutectoid decay of the δ phase at 1280°C were established. The temperature of the polymorphous transformation of $ZrCr_2$ depends on the composition. The range of homogeneity of the compound was determined as equal to ~2%. (tr-auth)

38576 STUDY OF TRANSFORMATION KINETICS OF URANIUM ALLOYS UNDER SMALL LOADS. Collot, M. (CEA, Paris); Foure, M.; Lauque, J.-P.; Monti, H. Mem. Sci. Rev. Met., 65: 317-30(Apr. 1968). (In French).

The grain of uranium alloys containing small quantities of

chromium, silicon or molybdenum and zirconium can be refined over a large range of cooling rates. The transformation kinetics have been investigated for both continuous cooling and isothermal treatment. (auth)

38577 DEVELOPMENT BY ANNEALING OF THE WELDS PRODUCED BY ELECTRON BOMBARDMENT ON URANIUM–MOLYBDENUM ALLOYS WITH 1.5 WT PERCENT OF Mo. Collot, C.; Caput, M.; Guillaume, C. Mem. Sci. Rev. Met., 65: 331-44 (Apr. 1968). (In French).

Micrograph, radiocrystallographic and mechanical investigations of the development by annealing of the brittle structure found in U–1.5% Mo alloys welded by electron bombardment are described. Mechanisms involved in returning to the equilibrium condition ($\alpha + \gamma'$) are reported. (auth)

38578 NbZn–A μ-PHASE. Hunt, Coy R.; Raman, A. (Louisiana State Univ., Baton Rouge). Mater. Res. Bull., 3: 489-94 (June 1968).

A μ-phase was discovered in the Nb–Zn system. Its lattice characteristics resemble those of the $Nb_{19}Fe_{20}$ μ-phase. The lattice constants of the unit cell are a = 5.07 ± 0.005 Å, c = 27.49 ± 0.02 Å, c/a = 5.421 and cell volume = 611.8 Å^3. A phase of unknown structure, designated as μ', was also found in Nb–Zn alloys. (auth)

38579 STRUCTURAL EVOLUTION IN THE COURSE OF QUENCHING OR TEMPERING ZIRCONIUM–COPPER ALLOYS WITH A CONTENT OF LESS THAN 5 PERCENT BY WEIGHT COPPER. Couterne, A.; Cizeron, G.; Lacombe, P. (CEN, Saclay, France). J. Nucl. Mater., 27: 121-36(Aug. 1968). (In French).

Various zirconium–copper alloys with 1.1 to 1.6 or 2.4 wt % copper were quenched from the high-temperature β phase and their associated phase transformation studied. According to the quenching rate, the β phase gives rise to various metastable structures that can be subsequently decomposed by tempering. The fastest quenching-rates give rise to a ω phase of hexagonal structure (c/a = 0.624) which forms martensitically. If the ω phase is reheated, a linear expansion anomaly of +0.34% is found in the range from 418 to 455°C approximately; this corresponds to the decomposition of the ω phase into an α_s solid solution, which is a supersaturated solution of copper in hexagonal zirconium, similar to the α equilibrium solid solution. On isothermal tempering or on heating to higher temperatures, α_s decomposes into equilibrium α and a precipitate of Zr_2Cu. Only the most zirconium-rich alloys among those studied give rise to the metastable ω phase. The TTT curves for the decomposition of ω were determined over a wide temperature range. (auth)

38580 PRECIPITATION OF ALUMINIUM FROM SUPERSATURATED SOLUTION IN α URANIUM. Smith, A. F. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 27: 194-200(Aug. 1968).

The kinetics of the formation of precipitates from γ quenched adjusted uranium was studied by lattice parameter changes. It was established metallographically and by electron microscopy that only the phase UAl_2 precipitates on heating in the α phase. In the temperature range examined (350 to 600°C) the kinetics of precipitation were consistent with the nucleation and growth of precipitates on subgrain boundaries and on individual dislocations within subgrains. (auth)

38581 CRYSTAL STRUCTURE OF Pu_3Zn_{22}. Johnson, Quintin; Wood, David H.; Smith, Gordon S. (Univ. of California, Livermore). Acta Crystallogr., Sect. B, 24: 480-4(1968).

The structure of a compound present in the Pu–Zn system at the approximate stoichiometry $PuZn_{7.7}$ was determined from diffractometrically recorded, single-crystal intensities. The unit cell, containing four formula units of Pu_3Zn_{22}, is body-centered tetragonal with a = 8.85, c = 21.18 Å. The calculated density is 8.71 g/cm^{-3}, and the space group is $I4_1/amd$. This structure also accounts for the published powder pattern of a compound in the Ce–Zn system. Cell constants for Ce_3Zn_{22} are a = 8.930, c = 21.36 Å. (auth) (Denmark)

38582 DISCUSSION OF "GRAIN BOUNDARY DIFFUSION IN TUNGSTEN". Gifkins, R. C. (Univ. of Melbourne). Trans. Met. Soc. AIME, 242: 734-5(Apr. 1968).

A discussion of grain boundary diffusion in W, experimental methods, and dislocation models of high-angle boundaries is presented followed by an explanation of the basis of these models. (P.G.C.)

38583 RECRYSTALLIZATION OF THORIATED NICKEL ASSOCIATED WITH IMPURITY DIFFUSION. Hotzler, R. K.; Castleman, L. S. (Polytechnic Inst. of Brooklyn). Trans. Met. Soc. AIME, 242: 750-1(Apr. 1968).

Results of experiments to determine the effect of S on thoriated Ni are reported. Photomicrography indicates that specimens containing 2.4 vol % Th, exposed for 5 hr at 1000°C, recrystallized, showed considerable porosity, and a NiS phase at grain boundaries. Effects of Se were similar but reaction kinetics were slower. (P.G.C.)

38584 DISCONTINUOUS PRECIPITATION IN Cu–1.79 WT PERCENT Be. Mishima; Y.; Shiromizu, R. (Tokyo Univ.). Trans. Met. Soc. AIME, 242: 751-2(Apr. 1968).

The equilibrium gamma phase in Cu-Be alloys was shown by electron diffraction patterns, to form by discontinuous precipitation; the new phase nucleating at grain boundaries and growing into grains on both sides of the boundary. Annealing above 500°C restricted grain growth to one of the grains although the precipitate had the same orientation as the grain in which no growth took place. (P.G.C.)

38585 STUDY OF THE BETA TO ALPHA TRANSFORMATION IN LANTHANUM. Marcinkowski, M. J.; Hopkins, E. N. (Ames Lab., Iowa). Trans. Met. Soc. AIME, 242: 579-87(Apr. 1968).

An investigation has been made of the β(fcc) → α(hexagonal) transformation which occurs in lanthanum using both electrical resistivity and transmission electron microscopy techniques. It has been shown that the β phase can be retained below the transformation temperature by rapid quenching but that the sample immediately begins to transform to the α phase. The transformation is observed to nucleate in the vicinity of inclusions. Based on the above observations, a detailed model of the transformation has been advanced which involves the nucleation of an extrinsic stacking fault bounded by a pair of Shockley partial dislocations in the vicinity of some heterogeneity, i.e., an inclusion. The stress field of the resultant dislocation pair acts to nucleate extrinsic faults in adjacent planes and leads quite naturally to the $\beta \rightarrow \alpha$ conversion with a minimum of strain energy induced in the crystal. (auth)

38586 DISLOCATION STRUCTURES IN SLIGHTLY STRAINED TUNGSTEN, TUNGSTEN–RHENIUM, AND TUNGSTEN–TANTALUM ALLOYS. Stephens, Joseph R. (Lewis Research Center, Cleveland). Trans. Met. Soc. AIME, 242: 634-40(Apr. 1968).

Deformation substructures of polycrystalline tungsten, W-2, 9, and 24% Re, and W-3% Ta were studied by transmission electron microscopy. The stress-strain curve for unalloyed tungsten showed gradual yielding followed by work-hardening. Electron micrographs indicated a gradual increase in dislocation density with increase in strain up to 5.0%. Dislocations, although frequently jogged, were straight over moderate distances and were in a random array. Stress-strain curves for alloy specimens of W-2 and 9% Re and W-3% Ta exhibited a drop in stress at yielding followed by only slight work-hardening. Electron micrographs of these specimens after strains of 0.05, 0.1, and 0.5% revealed no change in dislocation substructure from the unstrained specimens. After 2.0% strain, the three alloys exhibited dense networks. W-3% Ta was characterized by straight, frequently jogged dislocations comparable with the dislocation structure in unalloyed tungsten after a similar amount of strain. In contrast, W-2% Re exhibited dislocations that contained widely spaced jogs, while W-9% Re had developed a cell structure after the relatively small strain of 2.0%. The W-24% Re alloy contained a few dislocations after 0.1% strain, while after 0.5% strain twins were evident. Dislocation slip bands apparently preceded the twins. The stress-strain curve for the alloy indicated that twinning commenced after approximately 0.25% strain. These results indicate that the primary effect of low rhenium concentrations (2 and 9%) in tungsten is to increase dislocation multiplication after macroyielding by reducing the Peierls-Nabarro force (lattice resistance to dislocation motion). The dislocation bands that precede twins in W-24% Re may be caused by localized internal stresses resulting from a metastable structure, for example, clustering of rhenium atoms. (auth)

38587 REDUCING OF GRAIN SIZES OF ROLLED BERYLLIUM METAL. Goto, Masaru; Tuya, Kazuo (National Research Inst. for Metals, Tokyo). Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 10: 429-33(Nov. 1967). (In Japanese).

Commercial beryllium plate was rolled to examine its recrystallization characteristics. The effective heat treatment conditions for reducing the grain sizes were obtained. The effect of rapidly heating and cooling by high frequency heating was studied. The heat treatment conditions for the start and completion of the recrystallization agreed with those previously described. The shortening of the annealing time at a higher temperature was more effective in reducing the grain sizes than the long period annealing near the recrystallization temperature. By annealing for about 1 min at 900°C using high-frequency heating, the large grain size was reduced considerably. (NSA of Japan)

38588 HAFNIUM–CHROMIUM SYSTEM. Carlson, O. N.; Alexander, D. G. (Ames Lab., Iowa). J. Less-Common Metals, 15: 361-70(Aug. 1968).

A phase diagram is proposed for the hafnium–chromium system based on the results of microscopic, x-ray, and thermal analyses. The main features of the diagram are: a Laves phase, $HfCr_2$, which melts congruently at 1825°C and undergoes a crystallographic transformation between 1320 and 1360°C; eutectic reactions at 1480°C and 29 at. % Cr and 1660°C and 86 at. % Cr; and a eutectoid reaction at 1390°C and 12 at. % Cr. It was confirmed that the stable form of $HfCr_2$ at low temperatures has the face-centered cubic, $MgCu_2$-type structure, while at high temperatures it has the hexagonal $MgZn_2$ structure. (auth)

Radiation Effects

Refer also to abstract 37775.

38589 (AD–663888) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August 1, 1967–October 31, 1967. Hawthorne, J. Russell; Serpan, Charles Z. Jr.; Potapovs, Uldis; Watson, Henry E. (Naval Research Lab., Washington, D. C.). Nov. 15, 1967. 52p. (NRL-MR–1833). CFSTI.

Results are reported of research effort devoted to an evaluation of sulfur and phosphorus content as radiation embrittlement sensitivity variables in A302-B steel. The radiation embrittlement of 12Ni–5Cr–3Mo maraging steel and companion weld metal at 250°F and at elevated temperatures. The radiation embrittlement resistance of LaCrosse Reactor pressure vessel plate and test weldment, an evaluation of irradiated Big Rock Point Reactor surveillance materials, the notch ductility characteristics of service-irradiated, PM-2A reactor pressure vessel steel, and the installation and calibration of a new remotely operated Charpy-V impact machine. (USGRDR)

38590 (GEMP–607) EFFECT OF HELIUM GAS BUBBLES ON THE CREEP DUCTILITY OF AN AUSTENITIC ALLOY. Woodford, D. A.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 20, 1968. Contract AT(40-1)-2847. 22p. (CONF-680432-1). Dep. CFSTI.

From American Society for Metals Seminar, Schenectady, N. Y.

Post-irradiation transmission electron microscopy has been performed on a split heat of a high temperature precipitation-hardened alloy (A-286) containing 0.001 wt % and 0.010 wt % natural boron. After annealing at 760, 845, and 955°C, foils were prepared from sections taken from close to the fracture of specimens creep tested to failure. The observations were compared with those previously obtained for undeformed specimens. Helium gas bubbles were found to be arranged in spherical shells around coarse precipitates believed to be TiN. Any effect of creep deformation on bubble size was masked by the annealing treatment, and the bubble size distribution did not differ systematically from that observed for the undeformed specimens. The measured increase in creep resistance with increasing helium atom concentration is explained in terms of a reduction of dislocation mobility. It is suggested that the reduced ductility and associated reduction in strain rate sensitivity after irradiation may be very sensitive to the gas bubble distribution. The observation of bubbles on dislocations lying in the boundaries may be particularly significant. (auth)

38591 METHODS TO DETERMINE THE INCREASE IN BRITTLENESS OF STEEL CAUSED BY NEUTRON IRRADIATION. Van Elst, H. C. (Metaalinstituut TNO, Delft, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 25, 41-59(1968). (In Dutch).

The processes occurring during a Robertson test of steel components below the transition temperature were obtained by making ultrafast photographs of the brittle crack. It was found that cracking occurs in steps. Such results were correlated with experiments in which a shock wave was absorbed in and reflected by a steel bar 6 × 6 mm. The energy absorbed by plastic deformation was determined electronically as a function of temperature and other parameters. Thus it was possible to predict the influence of neutron irradiation on larger components from experiments on neutron-irradiated small bars. (J.J.t B.)

38592 VARIATION OF SOLID FISSION PRODUCT AND GAS SWELLING IN URANIUM COMPOUNDS WITH THERMAL NEUTRON DOSE RATE. Harrison, J. W.; Davies, L. M. J. Nucl. Mater., 27: 239-40(Aug. 1968).

The results of studies on thermal-neutron-irradiated uranium compounds showed that as the yield of gaseous products increases with thermal neutron flux, the accompanying solid fission product yield decreases (due to loss of Cs because of the partial blocking of the ^{133}Xe and ^{135}Xe decay) and results in a significant decrease in the solid fission product swelling over a range of fluxes 10^{12} $n/cm^2 \cdot sec$ to 10^{15} $n/cm^2 \cdot sec$. Data on solid swelling coefficients are tabulated. (P.C.H.)

38593 INFLUENCE OF OXYGEN ON THE MECHANICAL PROPERTIES OF ZIRCONIUM–COPPER ALLOYS. Kaden, W. (Siemens Aktiengesellschaft, Erlangen, Ger.). J. Nucl. Mater., 27: 225-34(Aug. 1968). (In German).

When zirconium alloys are placed in an oxygen-containing atmosphere at temperatures above 400 to 500°C, oxygen diffuses into the metal. To investigate the embrittlement caused by this, both specimens with uniform oxygen content across the entire cross section and specimens with an oxygen concentration gradient were examined. At room temperature samples containing more than 0.5 wt % oxygen behave in a brittle manner. This implies that samples containing an oxygen-rich zone produced by oxygen diffusion are partially embrittled: about half of the diffusion zone as traced out by means of microhardness measurements is embrittled. As the temperature increases, the boundary between the ductile and brittle regions is displaced towards higher oxygen concentrations. At 600°C this boundary lies somewhat below 5.5 wt % oxygen. Cracks generated in the metallic phase of oxidized and embrittled samples terminate at the boundary of the above-mentioned embrittled regions. (auth)

38594 EFFECT OF ARGON ION IRRADIATION ON THE INTERNAL FRICTION OF GOLD. Loebach, D. C.; Bowden, P.; Birnbaum, H. K. (Univ. of Illinois, Urbana). Acta Met., 16: 997-1008(Aug. 1968). (COO–1198-484).

The effect of low-energy (300 eV) argon ion irradiation on the internal friction of gold was studied in the temperature range from 80 to 373°K. Two dominant effects were noted; a decrease in internal friction after irradiation at temperatures above about 240°K and an increase after irradiation at 80°K. The changes in internal friction were studied as a function of dose in both temperature ranges. The experimental data were interpreted on the basis of a model that describes the annealing of gold interstitial atoms introduced by the ion irradiation. The decreases in damping after high-temperature irradiation were ascribed to dislocation pinning by mobile interstitials while the damping increases after low-temperature irradiation were explained by the formation of glissile dislocation loops as a result of interstitial clustering. Using this model the temperature above which the interstitials introduced by ion irradiation exhibited long-range migration to form interstitial clusters was about 120°K. No evidence for a damping peak associated with interstitial reorientation was found. (auth)

38595 EFFECTS OF NEUTRON IRRADIATION ON THE ACTIVATION PARAMETERS FOR SLIP IN IRON. McRickard, S. B. (Brookhaven National Lab., Upton, N. Y.). Acta Met., 16: 969-74(Aug. 1968). (BNL–12019).

The effect of fast neutron irradiation on the rate controlling mechanism for slip in iron and dilute iron alloys was investigated. Stress relaxation techniques were used to determine the components of the applied stress and the activation volumes. The activation enthalpy was estimated from the temperature dependence of the effective stress. To reduce the problem of heterogeneous deformation in irradiated iron the tests were performed at low strains (<0.01). Based on the parameters determined in this type of analysis it was concluded that irradiation to 2×10^{18} nvt (E > 1 MeV) does not change the deformation mechanism in iron and dilute iron–carbon alloys but merely increases the long-range internal stress. However, after source hardening is overcome by prestrain, some modification in the flow mechanism may take place. The yielding process near room temperature apparently can be changed by nitrogen additions. After irradiation, however, the process appears to revert to the same one operating in the base Ferrovac iron. (auth)

Ceramics and Cermets

38596 CERAMICS IN THE MODERN WORLD. Chandler, M. London, Aldus Books, 1967. 192p. 22s. 6d.

A chapter is included on "special" ceramics, including those of interest in the nuclear field. (UK)

Preparation and Fabrication

Refer also to abstracts 37830, 39905, and 39937.

38597 (AECL–2783) ON THE CHEMICAL STABILITY OF UO_2- AND PuO_2-FUELLED GRAPHITE. Perron, P. O. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb. 1968. 57p. Dep. CFSTI. CAN. $1.50.

Results of a study of the thermodynamics of UO_2- and PuO_2-

fueled graphite systems are presented that indicate that reduction of oxides to metals or carbides is not a problem with such fuels. Low pressures of carbon monoxide would be sufficient to inhibit the reactions. However, PuO_2 is easily reduced to PuO_{2-x} and hyperstoichiometric UO_{2+x} can be reduced to UO_2 (or UO_{2-x} if $T \lesssim 1600°C$), so that the equilibrium pressure of CO in a sealed fuel element could become excessive. The various pressure-controlling factors outlined and discussed include the initial average oxygen/metal ratio of the oxide dispersed in graphite, the temperature profile across the fuel, the ratio "M/V," where "M" is the mass of oxide dispersed in graphite and "V" is the free volume of the fuel, and the availability of oxygen-containing gases in the fuel, i.e., sorbed oxygen and moisture. (P.G.C.)

38598 (BARC-314) DEVELOPMENT OF HIGH DENSITY AND CONTROLLED MICROSTRUCTURE IN SINTERED URANIA PELLETS. Moorthy, V. K.; Anandan, N. S. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 55p. Dep.

Results of a study of the relations between powder properties, sintering treatments, and the densification and microstructure development in urania pellets are reported. Urania powders were prepared from ammonium diuranate by decomposition and reduction at 400, 600, 900, 1200, and 1500°C. Pellets prepared from these powders were sintered at 1200 to 1700°C with different soaking periods. The influence of sintering temperatures, soaking periods at different temperatures, intermediate soaks at varying time periods at various temperatures, reheating of the prepared sintered pellets, and rates of heating during sintering, on the density and microstructure development of pellets was studied. The study revealed that urania pellets of specified density and grain development can be prepared by first attempting to achieve densification and continuing the thermal treatments to attain the desired grain size and microstructure. (auth)

38599 (BARC-319) PREPARATION OF HIGH DENSITY URANIUM MONOCARBIDE (UC) PELLETS BY REACTION SINTERING OF A MIXTURE OF URANIUM DICARBIDE AND URANIUM METAL POWDERS. Moorthy, V. K.; Zope, B. D. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 15p. Dep.

Single phase UC pellets of high density were prepared by reaction sintering of pellets made from stoichiometric mixtures of uranium dicarbide and uranium metal powder. It was found that the formation of monocarbide starts at 1000°C and is completed at 1300°C. This process has the additional advantage that high density can be attained even in the green state. Pellets of a density of about 97% theoretical were obtained by pressing the stoichiometric mixture at 800 to 1200°C. The conversion to UC was brought to completion by subsequent vacuum sintering at about 1400°C. (auth)

38600 (BM-RI-7137) CAST HAFNIUM CARBIDE-CARBON ALLOYS: PREPARATION, EVALUATION, AND PROPERTIES. Adams, R. P.; Copeland, M. I.; Deardorff, D. K.; Lincoln, R. L. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). June 1968. 54p.

Arc-melting and centrifugal-casting methods were investigated for preparing shapes of hafnium carbide with and without excess carbon. Highly satisfactory equipment was constructed and efficient operating procedures were established. Methods for preparing consumable electrodes and shrink-tolerant graphite molds were developed. Although crack-free hafnium carbide (6.3 weight-percent carbon) shapes were not made, coherent castings containing 9 to 13.5 weight-percent carbon were produced; the same compositions were shown to be resistant to thermal shock. Selected physical and chemical tests were performed on castings chosen for investigation by chemical and nondestructive inspection techniques. Electrical conductivity and thermal expansion measurements were made. Measurable oxidation of all the compositions studied was observed to start between 500° and 600°C. Attack by nitrogen, however, did not occur until temperatures exceeded 2000°C. A linear relationship of the logarithm of the diamond pyramid hardness to the temperature was noted. Considerable scatter of the bend-rupture strengths at room temperature and of the tensile strengths up to 2000°C was found. However, at the latter temperature and above, a definite relationship of strength to temperature was observed and some ductility was noted. (auth)

38601 (DP-1085) SINTERING UO_3 TO DENSE UO_2. Cole, G. Rolland; Smith, P. Kent (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1968. Contract AT(07-2)-1. 15p. Dep. CFSTI.

Sintering of compacted hydrated UO_3 at 1600°C in hydrogen produced $UO_{2.06}$ pellets with bulk density of only 90% of theoretical, 5% less than the UO_2 density desired. The effects on UO_2 density of temperature, hydration, compacting pressure, ball-milling, and additives are described. (auth)

38602 (JPRS-45339) CERMETS IN ATOMIC TECHNOLOGY. Meyerson, G. A. Translated from Porosh. Met. Akad. Nauk Ukr. SSR, 7: No. 11, 50-65(1967). 29p. GPO.

Powder metallurgy as used in atomic technology is reviewed. It is noted that powder metallurgy techniques are used in creation of materials and articles with attributes not attainable with conventional methods and in production of articles and materials at lower cost than those produced by conventional methods. Information is included on powder metallurgy of U, U cermets, powder metallurgy of Th, powder metallurgy of U carbides, UC-ZrC solid solutions, powder metallurgy of Be, preparation of Zr powder, and production of neutron absorbers. (J.R.D.)

38603 (N-68-10078) FABRICATION AND CHARACTERIZATION OF HOT-PRESSED TANTALUM CARBIDE. Leipold, M. H.; Becher, P. F. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 1, 1967. Contract NAS7-100. 13p. (NASA-CR-90036; JPL-TR-32-1204. CFSTI.

The microstructure and chemistry of a series of compacts of tantalum carbide hot-pressed from several commercially available powders were studied. Variations in behavior of the powders were observed during hot-pressing. These variations did not correlate with measured characteristics of the material. Densification did not appear to be a diffusion-controlled process; some evidence points to plastic deformation as a possible controlling process. Grain growth rates during pressing were 42 or 165 kcal/g mole, depending on the source of powder. The difference was not explained. An impurity grain boundary phase of Ta_2O_5 was observed as were variations in the tantalum/carbon ratio within a given compact. (STAR)

38604 (SC-T-68-1535) PREPARATION AND CHARACTERIZATION OF ULTRAFINE CARBIDES, NITRIDES, AND METALS. Neuenschwander, E. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from J. Less-Common Metals, 11: 365-75(1966). 15p. Dep. CFSTI.

This report was abstracted from the original language and appeared in NSA as 20: 43951. (R.C.K.)

38605 NUCLEAR FUEL ELEMENTS. Feraday, M. A. (to Atomic Energy of Canada Ltd.). Canadian Patent 783,670. Apr. 23, 1968.

A two component uranium-based fuel element is described that has better neutron economy than known single component fuels with similar swelling and corrosion resistance properties. An inner core of U metal adjusted with 200 to 500 ppM Fe and 500 to 1200 ppM Al is surrounded by an U alloy of Zr, Mo, Nb, or Al. This and an outer sheath of some Zr alloy provide restraint and direct core swelling into a central void comprising 5 to 15% the volume of the rod. The fuel element described is for use in pressurized water, fog, or steam cooled reactors. (F.S.A.)

38606 METHOD AND APPARATUS FOR SHAPING, BY EXTRUSION, METALLIC CARBIDES AND IN PARTICULAR URANIUM MONOCARBIDE. Accary, Andre; Magnier, Pierre; Marchal, Michel (to Commissariat a l'Energie Atomique). British Patent 1,115,917. June 6, 1968. Priority date July 17, 1964, France.

Metallic carbides, particularly UC_2, are extruded in high-strength graphite dies, in vacuum, at temperatures above 1600°C under pressures of 200 to 1000 kg/cm^2. (P.G.C.)

38607 SOVIET RESEARCH ON PROTECTIVE COATINGS FOR GRAPHITE. Lankard, David R. (Battelle Memorial Inst., Columbus, Ohio). Curr. Awareness Bull., No. 9, 10-18 (Apr. 1968).

Soviet research on protective coatings for graphite, conducted from 1959 to 1967 is reviewed. Coatings discussed include those of refractory borides, carbides, nitrides, and silicides, and enamel-types prepared from mixtures of boron or barium silicate glasses mixed with various transition metal carbides, borides, and silicides. Techniques of application reviewed involve slurries, flame spraying, impregnation and decomposition, vapor deposition, plasma deposition, and gaseous diffusion. (P.G.C.)

38608 NATURE AND THERMAL EVOLUTION OF AMORPHOUS HYDRATED ZIRCONIUM OXIDE. Livage, J.; Doi, K.; Mazieres, C. (Ecole Nationale Superieure de Chimie, Paris. Faculte des Sciences, Orsay, France). J. Amer. Ceram. Soc., 51: 349-53 (June 1968).

The thermal behavior of amorphous hydrated zirconium oxide and its coprecipitates with other oxides was studied. Solid solution with a limit of solubility seems to exist in the amorphous coprecipitates. A relation with the high-temperature solid solution was established. The structure of the amorphous zirconia was studied by x-ray and neutron diffraction; a thin plate model related to the structure of tetragonal zirconia is proposed. Heating the precipitates in an oxygen-free atmosphere produced a black non-

stoichiometric oxide and stabilization of the tetragonal form. (auth)

38609 ELECTROLYTIC REFINING OF ZIRCONIUM CARBIDE. Suchkov, A. B.; Meerson, G. A.; Olesov, Yu. G. Izv. Akad. Nauk SSSR, Metal., No. 3, 106-8(May-June 1968). (In Russian).

The optimum procedure for electrolytic refining of zirconium carbide, during which coarsely crystalline precipitates of technically pure metal are formed, was established. The yield of zirconium from the anode material can reach 91.7%. Electrolytic refining of the carbide requires additional energy in comparison with the refining of the metal whose energy is equal to the change of the isobaric potential of the formation of the carbide. (tr-auth)

38610 APPARATUS FOR THE ELECTROLYTIC REFINING OF NUCLEAR METALS. Wurm, Joseph Gerard (to European Atomic Energy Community). U. S. Patent 3,380,907. Apr. 30, 1968. Priority date Sept. 13, 1962, Germany.

The apparatus comprises an electrolysis vessel made of electrically conductive metal, such as copper, and formed as a double-walled internally cooled field concentrator intended to concentrate the energy from a high frequency induction coil, surrounding the apparatus, on the cathode metal. The said metal is placed in a crucible located at the bottom of the vessel and made of refractory material. The said cathode metal and the electrolyte above it are kept in a molten state by this energy. The copper vessel is concentrically mounted in a reaction chamber containing an inert atmosphere. The anode is dipped in the molten salt bath above the crucible. Operating with a salt charge of NaCl, KCl, and UCl_3, a skull of solid salt mixture is formed on the inner wall of the cooled copper vessel whereby to avoid corrosion of the vessel. (auth)

38611 DOPED HYPOSTOICHIOMETRIC DIOXIDE NUCLEAR FUEL COMPOSITION AND METHOD OF PREPARATION. May, John Edward; Stoute, Richard Lloyd (to Atomic Energy of Canada, Ltd.). U. S. Patent 3,374,178. Mar. 19, 1968. Filed May 3, 1965.

A ceramic reactor fuel mixture is composed of oxides of U and/or Th with the O : metal ratio of 1.90 to 1.998 with a minor quantity of an additive oxide of a metal selected from the group consisting of Y, La, and Nb. The additive is present in the range of 0.1 to 1.0 at. %. The oxides are intimately mixed, sintered, and the dioxides reduced to a hypostoichiometric state at a temperature in the range of about 1700 to 2000°C. (B.L.M.)

38612 INVESTIGATION OF CONDITIONS FOR OBTAINING THE SPHERICAL GRANULES OF TUNGSTEN CARBIDE. Zakharova, G. I.; Kalinina, N. G.; Neshpor, V. S. Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 1-5(May 1968). (In Russian).

The conditions for obtaining the spherical powders of tungsten carbide by the rotation method were investigated. The type of powder granulation is described by its dispersity and moisture; the values of the apparent specific weight and general porosity are determined. (auth)

38613 NEW TECHNIQUE FOR THE PREPARATION OF THIN UO_2 FOILS FOR ELECTRON MICROSCOPIC OBSERVATION. Be, C. A.; Pedrazzini, G. (CISE, Milan). Met. Ital., 59: 320-2 (1967). (In Italian). (CISE-E-617).

A technique for the preparation of thin sintered foils of UO_2 and UO_2–ThO_2 mixtures is illustrated. The technique is also efficient for thermally treated sintered UO_2. The results and observations made are described. (tr-auth)

38614 PRODUCTION OF SILICIDES OF TRANSITION METALS BY THE AUXILIARY METAL BATH PROCEDURE. Jangg, Gerhard; Kieffer, Richard; Koegler, Heinz (Technische Hochschule, Vienna). Z. Metallk., 59: 546-52(July 1968). (In German).

Synthesis of intermetallic compounds from the elements in the melt of an auxiliary metal, which dissolves the reactants and is chemically removed after the reaction, is called the "auxiliary metal bath procedure." This procedure is suitable for producing the stable, hard, high-melting, and oxidation resistant silicides of the transition metals. The suitability of various metals as auxiliary metals is estimated based on thermodynamic considerations. Theoretical expectations were corroberated experimentally. In auxiliary metals exhibiting a high affinity to silicon an excess amount of silicon is required. In inert auxiliary metals stoichiometric contents of the reactants are sufficient. During the dissolution of the auxiliary metal the silicides may, also, be partially dissolved. In order to estimate these losses the resistance to chemical attack was investigated. Diluted nitric acid is usually suitable as a solvent. There are only a few stable silicides which cannot be isolated. They could be analyzed using an electron microprobe. (auth)

38615 APPARATUS FOR MELTING OXIDES. (to NUKEM Nuklear-Chemie und-Metallurgie Gesellschaft mit Beschrankter Haftung). British Patent 1,120,329. July 17, 1968. Priority date Apr. 29, 1966, Germany.

An apparatus for melting finely divided UO_2, PuO_2, or mixtures of these powders is described. Melting is induced in the powders by electric current passage. (J.R.D.)

38616 MANGANESE GLASS-MOLYBDENUM METALLIZING CERAMICS. Fulrath, R. M.; Hollar, E. L. (Sandia Corp., Albuquerque, N. Mex.). Amer. Ceram. Soc. Bull., 47: 493-7(May 1968).

A study to simplify the process of metallizing alumina ceramics and reduce the rigid process parameter controls now necessary. The goal was to achieve a simple metallizing mixture that could be fired in hydrogen of variable moisture content on sapphire or any of the available alumina ceramics currently manufactured. Time and temperature of firing were the 2 process parameters varied to accommodate different alumina ceramic compositions. A composite system model for the metallizing layer in a metallizing process is presented. Based on some important points of this model a Mn glass-Mo powder mixture is formulated to produce a bonding structure which is similar to that found in Mo–Mn conventional metallizing. This technique eliminates some of the intermediate reaction steps necessary in the Mo–Mn process which require careful process control. Using this glass-Mo metallizing mixture, single crystal sapphire and commercial alumina ceramics between 94 and 99.6 wt % alumina were successfully metallized. Metallizing was performed in dry hydrogen at 1400°C for 45 min. Electron microprobe analysis of a conventional Mo–Mn metallized layer and a glass-Mo metallized layer show marked similarities. (BBB) (auth) (TSS)

Properties Evaluations

Refer also to abstracts 37936, 38533, and 38534.

38617 (AD-663267) HIGH-TEMPERATURE MEASUREMENTS OF THE RATE OF UPTAKE OF TeO_2 VAPOR BY SELECTED OXIDES. Adams, Charles E.; Balkwell, William R.; Quan, Jack T. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 10, 1968. 57p. (USNRDL-TR-67-134). CFSTI.

The rates at which substrate samples of calcium ferrite and of clay loam took up vaporized TeO_2 were measured. The rate measurements were made for uptake in air from 900 to 1500°C and over a TeO_2 partial-pressure range of about 0.0000005 to 0.0002 atm. It was found that the rate of uptake of TeO_2 by the calcium ferrite was two to three orders of magnitude faster than the rate of uptake by the clay loam. The rate-controlling process for the uptake of TeO_2 by the calcium ferrite was the diffusion of the TeO_2 vapor molecules through the air. No unique rate-controlling process was found for the uptake of TeO_2 vapor by the clay loam. In this system, the rate seemed to be controlled both by a slow rate of reaction of the TeO_2 at the clay loam surface and by the slow diffusion of the condensed TeO_2 into the clay loam. (USGRDR)

38618 (AEC-tr-6878) DISPERSION-FUEL NUCLEAR REACTOR ELEMENTS. Samoilov, A. G.; Kashtanov, A. I.; Volkov, V. S. Translation of Dispersionnye Teplovydelyayushchie Elementy Yadernykh Reaktorov, Atomizdat, Moscow, 1965. 223p. (TT-68-50327; IPST-Cat.-5129). Dep. CFSTI.

The design and uses of dispersion-fuel elements are described. The properties required for the utilization of materials as a dispersion fuel are given. Phase diagrams of dispersion systems are included. Fabrication methods described for the production of cores for fuel elements include melting, casting, and powder metallurgy. The common methods of canning dispersion-fuel elements are described. Mechanical and physical properties given of compositions of dispersion-type fuels include those fabricated by melting, casting, and powder metallurgy methods. Determination of stability, evaluation of burnup limits, changes in properties of structural materials, and other results of dispersion fuels and fuel elements during irradiation are discussed. (J.C.W.)

38619 (BNWL-704) THE THERMAL DIFFUSIVITY AND THERMAL CONDUCTIVITY OF STOICHIOMETRIC $(U_{0.8}Pu_{0.2})O_2$. Gibby, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

Thermal diffusivity of stoichiometric sintered and annealed uranium–plutonium oxides was measured by laser heat-pulse apparatus. Thermal conductivity was calculated from the thermal diffusivity data. Results indicate that the thermal conductivity of the mixed oxide is essentially the same as that of pure UO_2. (P.G.C.)

38620 (GAMD-8326) BARIUM DIFFUSION IN PYROLYTIC CARBON AND SILICON CARBIDE. Selleck, E. (Gulf General Atomic, Inc., San Diego, Calif.). May 15, 1968. Contract AT(04-3)-167. 12p. Dep. CFSTI.

A method is given which permits the examination of diffusion profiles of specific fission products across typical uncontaminated coating materials. Graphite disks were coated with various materials, loaded into crucibles, activated in TRIGA, annealed at 1400°C, and unloaded. Analysis by gamma spectrometry showed the barium activity and results are graphed. The diffusion profiles of barium-140 in the pyrolytic carbon and silicon carbide coating are given. (J.C.W.)

38621 (KFK-tr-252) AENDERUNG DER UO_2-HAERTE MIT STEIGENDER TEMPERATUR UND AENDERUNG DES UO_2-KRISTALLGEFUEGES BEIM GLUEHEN. (Change of UO_2 Hardness with Rising Temperature and Change of Crystal Structure by Annealing). Nishijima, T.; Kawada, T. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, Ger.), from Nippon Genshiryoku Gakkaishi, 6: 154-8(1964). 10p. (In German). Dep.

The hardness of UO_2 sintered samples was measured at temperatures from −180 to 800°C. Comparative measurements were made for Ni, Mo, and W. W and UO_2 have similarities in the temperature dependence of the hardness. The samples were crushed and annealed at various temperatures. Micrographs of the surfaces taken at temperatures from 24 to 810°C show that the fissures arising on the crushed surfaces vary with increased temperature. When the samples indented at temperatures from room temperature to 800°C were annealed at 1200 to 1700°C, a crystal structure arises that is characteristic for the annealing temperature. The significance of these results was discussed. (J.S.R.)

38622 (LA-3795) THE CHEMICAL DIFFUSION OF CARBON IN THE GROUP VI-B METAL CARBIDES. Fries, R. J.; Cummings, J. E.; Hoffman, C. G.; Daily, S. A. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 32p. (CONF-680603-1). Dep. CFSTI.

For presentation at 6th International Plansee Seminar on High Temperature Materials, Fundamental and Developments, Reutte, Tirol, Austria.

The chemical diffusion of carbon in tungsten, molybdenum, and chromium carbides was studied by measuring the growth rates of the carbide layers on appropriate metal samples. The rate-determining step of the diffusion process was found to be the diffusion of the carbon through the carbide phases. Grain boundary diffusion was unimportant. Tungsten carbide layer growths were studied over the range 1500 to 2535°C. Below 2400°C, only the W_2C layer growth is important, although a thin WC skin is observed. The activation energy for W_2C layer growth is about 99.5 kcal/mole. Alpha-WC was observed to have an anomalously low layer-growth rate and a very high activation energy (~300 kcal/mole), while the layer-growth rate of β-WC_{1-x} is comparable to that of the other transition metal monocarbides. The growth of the molybdenum carbides was studied from 1200 to 2100°C. Below ~1415°C, Mo_2C growth with an activation energy of 114 kcal/mole is observed, while above this temperature the activation energy is only 68 kcal/mole. These observations are related to the order-disorder transition that occurs in the carbon sublattice of Mo_2C at about 1400°C. Above ~1800°C, both Mo_2C and MoC layer growths were observed, but the MoC growth rate was found to be limited by the supply of carbon to the surface of the sample. The diffusion of carbon into chromium was studied from 1200 to 1475°C. In this case, three carbide layers are found: a thin outside layer of Cr_3C_2 on a much thicker layer of Cr_7C_3 which, in turn, surrounds a thin layer of $Cr_{23}C_6$. The layer-growth rates increase in the order Cr_3C_2, $Cr_{23}C_6$, and Cr_7C_3 by factors of about two and seventeen, respectively. The activation energies are about 40 kcal/mole for both Cr_7C_3 and $Cr_{23}C_6$ and about 45 kcal/mole for Cr_3C_2. The growth rates of the Cr_7C_3 and $Cr_{23}C_6$ layers were decreased significantly by the presence of 0.3% oxygen in the chromium, while the growth rate of the Cr_3C_2 was not measurably affected. (auth)

38623 (LA-DC-8840) CARBON DIFFUSION IN THE CARBIDES OF URANIUM. Wallace, T. C.; Witteman, W. G.; Radosevich, C. L.; Bowman, M. G. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 45p. (CONF-680603-2). Dep. CFSTI.

From 6th International Plansee Seminar on High Temperature Materials, Fundamental, and Developments, Reutte, Tirol, Austria.

The chemical diffusion coefficient of carbon in UC_Y (face centered cubic, B1 structure type) has been determined as a function of composition and temperature. The heat of chemical diffusion has a maximum value of 142.5 ± 21.3 kcal/mole at approximately $UC_{1.3}$. U_2C_3 (body centered cubic, space group I43d) and α-UC_2 (body centered tetragonal, space group 14/mmm) layer growths were studied over the temperature ranges 1185 to 1780° and 1525 to 1780°C, respectively. Carbon self diffusion coefficients were calculated from the experimental data and known thermodynamic data. The results are given by the expressions: $D^C_{UC_{1.9}} = 0.30$ $e^-(63.5/RT)$ kcal/mole 1185° to 2347°C, $D^C_{U_2C_3} = 228$ $e^-(98.3/RT)$ kcal/mole 1185 to 1780°C, $D^C_{\alpha\text{-}UC_{1.83}} = 156$ e^- $(90.2/RT)$ kcal/mole 1525° to 1780°C, and $D^C_{\alpha\text{-}UC_{1.99}} = 9.5$ $e^-(77.2/RT)$ kcal/mole 1830° to 2347°C. From thermal diffusion experiments it is shown that the apparent heat of transport is positive for the single and two phase regions studied in the composition range $UC_{1.8}$ to $UC_{1.95}$. (auth)

38624 (N-68-10216) A NEW DEFORMATION MECHANISM IN PYROLYTIC CARBON AT HIGH TEMPERATURES. Jenkins, G. M. (Jet Propulsion Lab., Pasadena, Calif.). 1967. Contract NAS7-100. 25p. (NASA-CR-90028). CFSTI.

It is demonstrated that the creep deformation of pyrolytic graphite at high temperatures in response to a stress in an a-direction may be the result of the independent two-dimensional plastic distortion of each individual plane of carbon atoms. On the model the distortion within each plane is produced by the movement of unit c-axis dislocations mainly by climb from a generalized Herring−Nabarro mechanism. This has some bearing on creep in polycrystalline graphite at high temperature and under neutron irradiation. (auth) (STAR)

38625 (N-68-11625) MECHANICAL BEHAVIOR OF TANTALUM CARBIDE AND MAGNESIUM OXIDE. Leipold, M. H.; Nielsen, T. H. (Jet Propulsion Lab., Pasadena, Calif.). Dec. 1, 1967. Contract NAS7-100. 14p. (NASA-CR-90511; JPL-TR-32-1201). CFSTI.

Tensile fracture stress data at room temperature are presented for a series of hot-pressed polycrystalline MgO and TaC specimens. An unacceptably large number of failures in the end section of the MgO indicated the need for improved fabrication techniques. Data for the $TaC_{0.93}$ indicate a fracture stress of approximately 25 kg/mm² (35,000 psi) and a Young's modulus of 2.8×10^4 to 2.9×10^4 kg/mm² (39×10^6 psi). Data are presented in detail to permit subsequent analysis. (auth) (STAR)

38626 (WARD-3791-18) URANIUM PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1968. Biancheria, A.; Bishop, E. C.; Jacoby, W. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1968. Contract AT(30-1)-3791. 84p. Dep. CFSTI.

The current economics, program, and progress are discussed. Contract administration and project planning, coordination, and control continue. The production of fuel pellets for GETR Phase I irradiation test capsules was completed, and archive samples of each GETR fuel type were prepared. The fabrication line was then closed down and cleared of all remaining fuel material for an accountability check followed by an audit. Fabrication of material for the EBR-II test pins was started. The buttons made in 1966 at Battelle Memorial Institute were found to have oxidized and were unsuitable as starting material for the fuel. New buttons had to be prepared from raw materials; and two batches of material have been fabricated. Nine fuel pins for the GETR Phase I irradiations were fabricated, and preparations were made for the fabrication of EBR-II Phase test capsules. Dummy fuel pellets were used to establish and verify an acceptable pin-bonding technique. A fabrication process was completed for the vanadium alloy tensile specimen container assembly to be inserted in the EBR-II Phase I capsules. Mock-up EBR-II Phase I capsules were fabricated and characterized using dummy pins and dummy container assemblies. Closure welding process development was started on three different irradiation pin sizes. Pertaining to the sodium bond heat transfer behavior, experimental testing in water using flat plate and cylindrical geometries continue. Work on an analytical prediction of the thermal and hydrodynamic behavior of the sodium bond was performed. Fabrication of the sodium vapor deposition test apparatus was completed, and all components were checked-out. The test conditions for initial operation of the apparatus were defined. The fabrication, assembly, and inspection of all GETR Phase I capsules were completed. The capsules were inserted into designated GETR pool positions by V-RAFT's and brought to power. The instrumentation operating procedures were completed. Arrangements for post-irradiation shipping and examination were started. The EBR-II Phase I design and hazards report was completed for submittal and approval. EBR-II Phase II design studies were conducted and show the need for a high performance sub-assembly, probably containing 12 capsules, to attain ratings above 30 kW/ft. A review of the irradiation program was started to assure its conformance with current policy on mixed carbide fuel development. (J.C.W.)

38627 RESIDUAL STRESS AND GRAIN DEFORMATION IN EXTRUDED POLYCRYSTALLINE BeO CERAMICS. Smith, Deane K. Jr.; Weissmann, Sigmund (Univ. of California, Livermore. Rutgers-The State Univ., New Brunswick, N. J.). Contract W-7405-eng-48. J. Amer. Ceram. Soc., 51: 330-6(June 1968). (UCRL-70614).

Residual strain measurements on a series of sintered BeO tubes indicate that significant stresses developed during processing from the thermal expansion anisotropy. X-ray topographic studies show that the resulting strains are preferentially located near grain and subgrain boundaries. Fine-grained samples, 20μ and less, do not show pronounced subgrain structure and exhibit lower dislocation densities in the grain interiors than do coarse-grained-samples. (auth)

38628 OXYGEN DIFFUSION IN MONOCLINIC ZIRCONIA. Madeyski, A.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). Mater. Res. Bull., 3: 369-76(Apr. 1968).

Oxygen self-diffusion coefficients have been determined for near-stoichiometric monoclinic zirconia exposed in an oxygen atmosphere at 300 mm Hg pressure at temperatures in the range 800 to 1000°C. These evaluations obeyed the equation: $D(cm^2/sec) = 9.73 \times 10^{-9} \exp -56{,}000/RT$. The results were interpreted by an anti-Frenkel type defect model, the transport number for oxygen ions being 4.5×10^{-3} at 990°C. (auth)

38629 PREPARATION AND INVESTIGATION OF SOME PROPERTIES OF THE ALLOYS NbC–WC AND TaC–WC. Panov, V. S.; Meerson, G. A. (Moscow Order of Labor Red Banner Inst. of Steel). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 46-53 (May 1968). (In Russian).

The results of an investigation of resistivity, microhardness, parameter of crystal lattices, boundary angle of wetting, and coefficient of thermal expansion depending on the composition in the systems NbC – WC and TaC – WC are reported. The investigated alloys were verified by means of roentgenographic and chemical analyses; their metallography and conditions of thermal treatment are shown. (auth)

38630 MODULE OF NORMAL ELASTICITY OF POROUSLESS TITANIUM AND ZIRCONIUM NITRIDES. Portnoi, K. I.; Mukaseev, A. A.; Gribkov, V. N.; Levinskii, Yu. V. (All-Union Order of Lenin Scientific-Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 87-90(May 1968). (In Russian).

The modulus of elasticity of dense titanium and zirconium nitrides are determined by the method of measuring ultrasonic speed. The obtained values are $E_{TiN} = 61{,}600 \pm 2000$ kg/mm^2 and $E_{ZrN} = 51{,}000 \pm 1500$ kg/mm^2. These values are used for calculation of characteristic temperatures which proved to be equal: $\Theta_{TiN} = 796 \pm 15°K$ and $\Theta_{ZrN} = 580 \pm 10°K$. The obtained values of the modulus of elasticity and characteristic temperature exceed values given in literature. (auth)

38631 PORE MIGRATION IN CERAMIC FUEL ELEMENTS. Nichols, F. A. (Bettis Atomic Power Lab., Pittsburgh). J. Nucl. Mater., 27: 137-46(Aug. 1968). (WAPD-T-2052).

An analysis is presented on the behavior of an initially spherical pore when placed in a thermal gradient. When the dominant mechanism of material transport is evaporation-condensation, the problem is solved from first principles to give: $\partial n/\partial t = \{\overline{D}_v \Omega C_0 \Delta H_v \nabla T/(kT_0^2)\} \cdot [\cos\theta + \tfrac{3}{2}\alpha \cdot \tfrac{1}{2}(3\cos^2\theta - 1)]$, where $\partial n/\partial t$ = outward normal velocity at pore surface, $\overline{D}_v$ = diffusion coefficient in vapor evaluated at T_0, Ω = molecular volume, C_0 = equilibrium concentration in vapor at average temperature T_0, $\alpha = (\nabla T R_0/T_0)(\Delta H_v/kT_0) < 1$, ΔH_v = heat of vaporization, k = Boltzmann constant, ∇T = thermal gradient, R_0 = pore radius and θ = normal polar angle. The first-order term of the equation predicts, if $\overline{D}_v$ (which is inversely proportional to the pressure in the pore) is not a function of R_0, a motion of the pore up the thermal gradient at a velocity independent of pore size. If the pressure is assumed to be dictated by surface tension effects (and therefore inversely proportional to R_0) then the equation predicts a velocity that increases linearly with R_0. These results are in substantial agreement with previous approximate treatments for the migration velocity. The second-order term in the equation predicts a deviation from the spherical shape assumed as the starting point. The deviation is such that a spherical pore should, as it migrates, transform itself into an elongated or cigar-shaped form. Some speculations concerning the origin and stability of the lenticular voids sometimes observed are also presented. (auth)

38632 HIGH-TEMPERATURE ABSORPTION OF YVO_4 AND YVO_4:Eu. Davis, T. S.; Datta, R. K. (General Electric Co., Cleveland). Trans. Met. Soc. AIME, 242: 714-16(Apr. 1968).

Equipment and procedures developed to measure elevated-temperature reflectance and to explain increased brightness of YVO_4 and YVO_4-Eu phosphors in the ultra-violet region are described. (P.G.C.)

38633 ENTHALPY AND HEAT CAPACITY OF SCANDIUM SESQUIOXIDE AT HIGH TEMPERATURES. Tsagareishvili, D. Sh.; Yashvili, T. S.; Gvelesiani, G. G. (Inst. of Metallurgy, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 49: 175-80 (Jan. 1968). (In Russian).

Enthalpy and heat capacity of scandium sesquioxide was studied at 298 to 1600°K. The measurements of the high-temperature enthalpy were achieved by mixing in a massive calorimetric installation with an isothermal shell. The device for automatic dumping of the ampule from the calorimeter furnace is described. The equation obtained for the enthalpy (J/mole) as a function of absolute temperature at 298.15 to 1607.4°K was $H_T - H_{298.15} = 117.74T + 6.95 \times 10^{-3} T^2 + 26.78 \times 10^5 T^{-1} - 44702$ and for the true heat capacity of Sc_2O_3 (J/mole/deg) as a function of temperature it was: $C_p = 117.74 + 13.90 \times 10^{-3} T - 26.78 \times 10^5 T^{-2}$. The results obtained deviate from published data about ±5.7%. (R.V.J.)

Structure and Phase Studies

Refer also to abstract 39541.

38634 (LA-tr-68-27) QUESTION OF THE CUBIC TUNGSTEN CARBIDES. Krainer, E.; Robitsch, J. Translated by C. P. Kempter (Los Alamos Scientific Lab., N. Mex.), from Planseeber. Pulvermet., 15: 179(1967). 3p. Dep. CFSTI.

Measurements of the lattice parameters of stoichiometric cubic WC are discussed. (P.G.C.)

38635 (ORNL-tr-1918) INVESTIGATIONS OF URANIUM NITRIDES AND CARBONITRIDES. Naoumidis, A. (Kernforschungsanlage, Juelich (West Germany)). Translated from report JUL-472-RW. 98p. Dep. CFSTI.

An abstract of this paper was prepared from the original language and appeared as NSA 21: 45980. (auth)

38636 TRANSMISSION ELECTRON MICROSCOPY OF IRRADIATED UO_2 FUEL PELLETS. Manley, A. J. (United Kingdom Atomic Energy Authority, Windscale, Eng.). J. Nucl. Mater., 27: 216-24(Aug. 1968).

The microstructures of UO_2 fuel pellets have been examined by transmission electron microscopy after irradiation. Thin foil samples were successfully prepared by a chemical polishing technique. The fuel rim regions contained dislocation loops and tangles, black dots, and small gas bubbles (up to 150 Å dia). In the regions of equiaxed grain growth larger loops, helical dislocations, larger precipitates and 400 Å dia gas bubbles were present. The structure of the regions of columnar grain growth was consistent with radiation damage of material swept by migrating pores; in these regions the matrix contained no fission gas. Surface contamination, in the form of small particles, came from the UO_2 itself and consisted of solid fission products; one constituent may be URu_3. Some small particles extracted with nitric acid were found to have a hexagonal structure with a = 2.76 Å and c = 4.42 Å. Gas bubbles found in the as-irradiated foils did not account for the quantity of fission gases generated, but those found after pulse-annealing in the electron beam appeared to more than do some; either Kr and Xe are not the only gases involved or the surface energy of the matrix is less than 1000 erg/cm^2. Gas bubbles formed after beam-annealing were often found associated with black dots which appeared to nucleate them and to slow their subsequent movement; they were also found to precipitate preferentially on grain boundaries, although no gas bubbles were detected on grain boundaries in the as-irradiated condition. (auth)

38637 EFFECT OF CARBON ON THE δ-PERITECTOID REACTION IN URANIUM–SILICON ALLOYS. Wyatt, B. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 27: 201-15(Aug. 1968).

Alloys with silicon contents close to the U_3Si composition, containing different levels of carbon, were examined to determine the effect of carbon on the peritectoid reaction. Carbon concentrations up to 2000 ppM lower the peritectoid temperature and form a region of 3-phase equilibrium between U, U_3Si_2, and U_3Si. The 3-phase region has an upper limit of 860°C and a lower limit of 790°C in an alloy containing 2000 ppM carbon. Probable phase relationships, in the region of the U–Si–C system studied, are discussed. (auth)

38638 INVESTIGATION OF SOME BINARY NIOBIUM OXIDES. Trunov, V. K.; Kovba, L. M.; Pol'shchikova, Z. Ya. Zh. Neorg. Khim., 13: 1494-9(June 1968). (In Russian).

It was shown that in the system $Me_2O_3-Nb_2O_5$ (Me = Al, Cr, Fe) the binary oxides $Me_2O_3 \cdot 11Nb_2O_5$ (Me = Al and Fe) and $MeO_3 \cdot 49Nb_2O_5$ were formed. The lattice parameters of these compounds were determined. The hypothesis was made that the formation of the compounds $Nb_{25}O_{62}$ and $Me_2O_3 \cdot 49Nb_2O_5$ (Me = Sc, In) is to be expected. (tr-auth)

38639 CRYSTAL STRUCTURE OF Zr_2Se. Franzen, H. F.; Norrby, L. J. (Ames Lab., Iowa). Acta Crystallogr., Sect. B, 24: 601-3(1968). (IS-1726).

The crystal structure of Zr_2Se was determined and refined by x-ray single-crystal methods. Zr_2Se was found to be isostructural with Ta_2P (Nylund, Acta Chem. Scand., 20: 2392(1966)) and with Ti_2S (Owens, Conard & Franzen, Acta Cryst. 23: 77(1967)). (auth) (Denmark)

38640 METAL BORIDES IN BORON FIBER CORES; IDENTIFICATION OF MoB_4. Galasso, F.; Pinto, J. (United Aircraft Research Labs., East Hartford, Conn.). Trans. Met. Soc. AIME, 242: 754-5(Apr. 1968).

Results of studies are presented on phases formed in metal cores of Mo, Ta, and W wires used as substrates in the preparation of B fibers by vapor deposition. Emphasis is placed on diffusion kinetics, identification, and characterization of MoB_4. (P.G.C.)

38641 STRUCTURE AND ORIENTATION OF THE SECOND PHASE IN ZrB_2 CRYSTALS. Leombruno, W. J.; Haggerty, J. S.; O'Brien, J. L. (Arthur D. Little, Inc., Cambridge, Mass.). Mater. Res. Bull., 3: 361-8(Apr. 1968).

The nature of two orientated precipitates observed in high purity ZrB_2 single crystals is discussed. Optical and electron microscopy were used to identify the precipitates' crystal structures and their relative orientations to the ZrB_2 matrix lattice. Laser microprobe analysis of extracted particles was used to characterize them chemically. The morphology of the particles is determined by the match between the crystal lattices. (auth)

Radiation Effects

Refer also to abstracts 38592, 39783, 39789, and 39790.

38642 OXYGEN REDISTRIBUTION IN URANIUM DIOXIDE FUELS. Perron, P. O. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 27: 237-8(Aug. 1968).

Studies on oxygen redistribution in irradiated UO_2 fuels showed good agreement with previous and theoretical results. Various examples of oxygen redistribution are explained for stoichiometric UO_2, non-stoichiometric fuel absolutely free of C and H (or moisture), and non-stoichiometric fuel containing C or H. (P.C.H.)

Plastics and Other Materials

Refer also to abstract 37936.

38643 (CERN-68-13) EFFECT OF NUCLEAR RADIATION ON THE ELECTRICAL PROPERTIES OF EPOXY RESINS. Van de Voorde, Marcel (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 17, 1968. 45p. Dep.

Changes in the electric properties of epoxy resins used for electrical insulation in nuclear environments were measured as a function of nuclear radiation and temperature or frequency. Degradation occurred first in those parts of the polymer structure which were most mobile, i.e., ends of long chains. All resins containing a high aromatic content and cured with an aromatic amine or anhydride showed good radiation resistance. (P.G.C.)

38644 MECHANICAL PROPERTIES OF IRRADIATED WOOD. Jokel, Jozef (Statny Drevarsky Vyskumny Ustav, Bratislava). DREVO, 21: 232-5(July 1966). (In Czech).

The method of testing small dimension specimens and the results from bending, compressive strength, and toughness tests on spruce, beech, and oak wood exposed to beta radiation are described. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 38777, 38808, 38824, 38826, 38833, 38890, 38900, 38930, 39331, and 39489.

38645 (AD-668440) A COMPARISON OF 3.3 mm BURSTS AND H-ALPHA EMISSION. Report for March 1966-June 1967. Shimabukuro, Fred I. (Aerospace Corp., El Segundo, Calif.). Mar. 1968. Contract F04695-67-C-0158. 20p. (TR-0158(3230-46)-11; SAMSO-TR-68-141). CFSTI.

Radio bursts observed at a wavelength of 3.3 mm are always associated with flares. The enhancement in the millimeter emission is strongly correlated with some optical event that is associated with the flare. Emissions in the bursts observed thus far, with the possible exception of those associated with proton flares, have not been large increases over quiescent readings and can be explained by a thermal mechanism. (auth) (USGRDR)

38646 (AD-664509) INTERPLANETARY MAGNETIC FIELD: SOLAR ORIGIN AND TERRESTRIAL EFFECTS. Wilcox, John M. (California Univ., Berkeley. Space Sciences Lab.). Jan. 8, 1968. Contract Nonr-3656(26). 139p. CFSTI.

Many observations related to the large-scale structure of the interplanetary magnetic field, its solar origin, and terrestrial effects are discussed. During the period observed by spacecraft the interplanetary field was dominated by a sector structure corotating with the Sun in which the field is predominantly away from the Sun (on the average in the Archimedes spiral direction) for several days (as observed near the Earth), and then toward the Sun for several days, etc. The average sector appears to be a coherent entity with internal structure such that its preceding portion is more active than its following portion. Cosmic rays corotate with the interplanetary field, and there are differential flows associated with the sector pattern. Profound effects on geomagnetic activity and the radiation belts are produced as the sector pattern rotates past the Earth. The solar origin of the sector pattern is discussed. The solar source may be associated with the large-scale weak background photospheric fields observed with the solar magnetograph. It is suggested that there may be a rather continual relation between this solar structure and terrestrial responses, of which the recurring M-region geomagnetic storms are just the most prominent example. (auth) (USGRDR)

38647 (N-68-11819) RADIATION AGES AND GAS-RETENTION AGES OF CARBONACEOUS CHONDRITES AND OF UNEQUILIBRATED ORDINARY CHONDRITES. Heymann, D.; Mazor, E. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). 1967. 116p. (NASA-CR-90538; SM-87/44). CFSTI.

He, Ne, and Ar were determined by mass-spectrometry in 25 carbonaceous chondrites, and in 12 unequilibrated ordinary chondrites. The occurrence of primordial inert gases, and the possibility of severe diffusion losses in certain carbonaceous chondrites, leads to the following considerations: (1) U, Th-He ages cannot be estimated for the C1- and C2-type carbonaceous chondrites; (2) only "minimum" $^{3}He_{c}$ ages can be estimated for the C1- and C2-type carbonaceous chondrites; and (3) $^{38}Ar_{c}$ ages cannot be estimated for any of the meteorites, except Karoonda. The radiation ages of the carbonaceous chondrites and of the UOC are not grossly different from those of the ordinary chondrites. However, the following trends can be noted: (1) the ages of the C1 and C2 carbonaceous chondrites are on the average shorter than those of the ordinary chondrites; none of the former is greater than 15 Myr; (2) four, perhaps five C2 carbonaceous-chrondrites, Boriskino, Cold Bokkeveld, Haripura, Nawapali, and Nogoya come from a single collision 0.1 to 0.6 Myr ago, with the most likely date of 0.2 ± 0.1 Myr. (auth) (STAR)

38648 (N-68-12859) FLIGHT BURST RADIOMETER SYSTEM FOR RADIO ASTRONOMY EXPLORER SATELLITE. Final Report. (Airborne Instruments Lab., Deer Park, N. Y.). July 1967. Contract NAS5-9340. 72p. (NASA-CR-91288). CFSTI.

The solar burst radiometer system is used to measure the spectral distribution of solar bursts at frequencies below the ionospheric cutoff frequency. The satellite monitors phenomena caused by the interaction of electrons with the solar corona. The radiation burst characteristics are measured at 200 kc to 6 Mc. The radiometer has the secondary function of determining the level of continuous galactic emission. The radiometer equipment is contained in three separate packages; two preamplifiers and the main assembly. Two radiometers contain eight frequency channels each. The third unit contains six fixed-frequency channels and a variable frequency channel. The variable channel is programmed to step sequentially through 200 kc to 6 Mc in 32 steps, sampling a discrete frequency at each step. All three units contain a solid-state noise source which can be electronically controlled to provide seven calibration levels. (auth) (STAR)

38649 (N-68-14216) THE PECULIAR GALAXY NGC 7714. Demoulin, Marie-Helene; Burbidge, E. Margaret; Burbidge, G. R. (California Univ., La Jolla, San Diego). Nov. 1967. 26p. (NASA-CR-91800). CFSTI.

NGC 7714, one of the components of the system VV51, has an emission-line spectrum indicating strong excitation, and velocity gradients in the excited gas which are probably due to rotation but may include noncircular motions also. [O I] λ6300 which has so far been detected only in Seyfert galaxies, is present in the center, and the emission-line strengths approach those in Seyfert nuclei, but the lines do not show the characteristic Seyfert broadening. The mass is small (a few $\times 10^{9}$ $M_{\odot}$) but cannot be precisely determined because of uncertainty in the orientation and the possible presence of noncircular motion. (auth) (STAR)

38650 (N-68-14809) PLASMA MECHANISMS FOR SOLAR RADIO BURSTS. Tidman, D. A. (Maryland Univ., College Park). 1967. 21p. (NASA-CR-91665; CONF-671208-5). CFSTI.

From 134th Annual Meeting of the American Association for the Advancement of Science, New York.

Mechanisms for Type II (so-called slow drift bursts) and Type III (fast drift) bursts are considered. It has been suggested that the radiation emitted in these bursts has its origin in longitudinal electron plasma oscillations excited in the coronal plasma. These electron plasma oscillations convert part of their energy into electromagnetic radiation of frequency ω_e by scattering off density fluctuations (ion waves) in the corona, and part into radiation at $2\omega_e$ by scattering of longitudinal electron plasma waves off each other. Detailed calculations have shown that most of the features of Type-II bursts can be understood this way. In the following model it is shown that the electron plasma oscillations could be excited by suprathermal electron fluxes behind a "collisionless" shock wave rising through the corona above a solar flare. Although the same basic radiation process is almost certainly also responsible for Type-III bursts, some difficulties arise when one looks closely at the radiation process in this case. (auth) (STAR)

38651 (N-68-16008) MCFLARE: A MONTE CARLO CODE TO SIMULATE SOLAR FLARE EVENTS AND ESTIMATE PROBABLE DOSES ENCOUNTERED ON INTERPLANETARY MISSIONS. Lahti, Gerald P.; Karp, Irving M.; Rosenbaum, Burt M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 55p. (NASA-TN-D-4311). CFSTI.

A computer program MCFLARE that uses Monte Carlo methods to simulate solar-flare occurrences during an interplanetary space voyage is described. The total biological dose inside a shielded crew compartment due to the flares encountered during the voyage is determined. The computer program evaluates the doses obtained on a large number of trips having identical trajectories. From these results, a dose D_p having a probability p of not being exceeded during the voyage can be determined as a function of p for any shield material configuration. The user of the code selects any number of solar flares considered to be representative of the ones that will occur during future solar active periods. The flares are assumed to occur randomly during these periods. The dose at a distance of 1 astronomical unit (1.496×10^{8} km) from the Sun from each of these flares behind any shield configuration investigated is input to the MCFLARE code. The code accounts for the dependence of the dose received from a flare on the distance from the Sun according to a $(1/r)^{\alpha}$ variation, where r is the distance from the Sun and the exponent α can be assigned any integral value including zero. To illustrate the use of the code, a trip to Mars and return is calculated, and estimated doses behind several thicknesses of aluminum shield and water shield are presented. A FORTRAN IV listing, data input instructions, and sample output are given. (auth) (STAR)

38652 (N-68-16276) HYDROGEN AND HELIUM ABUNDANCES IN NEUTRON STAR ATMOSPHERES. Rosen, Leonard C. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1966]. 30p. (NASA-TM-X-60843). CFSTI.

The question whether one may identify a neutron star by observing hydrogen and helium lines in its spectra is examined. An analysis is presented of the burning and diffusion of hydrogen and

helium in a neutron star atmosphere. An initial two-component atmosphere of hydrogen and carbon and of helium and carbon is examined utilizing various photospheric temperatures. The hydrogen burns through the proton- proton reaction and the CN cycle, and the helium by the triple alpha process and alpha capture on carbon. It is found that only a negligible proportion of hydrogen or helium can exist after a few years in the neutron star atmosphere. Therefore spectra which include hydrogen and helium lines cannot be attributed to neutron stars. (auth) (STAR)

38653 (N-68-16483) HIGH ENERGY ELECTRONS AND EMISSION OF THE OMNIDIRECTIONAL SYNCHROTRON RADIATION IN RADIO FREQUENCY AND X-RAY REGIONS. Verma, Satya Dev (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). June 1967. 19p. (NASA-CR-92705; EFINS-67-48). CFSTI.

The recent measurements of the flux and differential energy spectrum of primary electrons in the 0.2- to 300-BeV energy region made near the recent solar minimum period (1966) are summarized. These measurements are consistent with a change in the exponent of the power law spectrum of primary electrons from 1.6 ± 0.15 to 2.6 ± 0.15 at about 2 to 5 BeV. It is pointed out that the observations of the omnidirectional intensity and the spectrum of the nonthermal radio frequency background radiation above 200 MHz are consistent with this steepening of the electron energy spectrum. Furthermore radio observations in the 10 MHz to 100 MHz region are in agreement with the lower energy electron spectrum corresponding to these radio frequencies (0.2 to 2 BeV) within 50%. This indicates that the residual solar modulation of electrons in the 0.2 to 2 BeV energy region is not large. If it is assumed that the electron energy spectrum extends in the form of a power law up to about $\approx 10^5$ to 10^6 BeV with the exponent (2.6, 2.8, or 3.0), then the synchrotron emission of these ultrahigh energy electrons would contribute to the recently observed diffuse component of cosmic x rays although it does not completely account for the large flux. This assumed electron spectrum would also give a possible explanation for the observation of a small number of air showers which may have been produced by the electron or photon component of the primary cosmic rays. (auth) (STAR)

38654 (N-68-17252) NUCLEAR CHARGE SPECTRA AND ENERGY SPECTRA IN THE SEPTEMBER 2, 1966 SOLAR PARTICLE EVENT. Durgaprasad, N.; Fichtel, C. E.; Guss, D. E.; Reames, D. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 29p. (NASA-TM-X-63111; X-611-68-55). CFSTI.

Heavy nuclei ($Z \geq 3$) were detected in the September 2, 1966 solar particle event. The proton energy spectrum was measured down to energies as low as 3 MeV and up to energies as high as 100 MeV, with measurements on the helium and heavier nuclei covering a more restricted range. The relative abundances of helium, light, medium, and heavy nuclei obtained in this experiment from about 14 to 35 MV/nucleon agree with those measured in previous solar particle events at higher energies and hence with those of solar photosphere. This result strengthens the concept of a multicharged nuclear composition which is a characteristic of solar particle events. The proton spectrum agrees with an exponential rigidity spectrum above 250 MV, but shows sharp deviations 250 MV early in the event. An examination of the relative abundances of protons and medium nuclei shows that the propagation of solar particles in this event cannot be described by a simple diffusion model with a diffusion coefficient proportional to β or βR. (auth) (STAR)

38655 (N-68-18064) STELLAR OPACITY PROGRAM MANUAL "STOP". Michels, Thomas E.; Kaskel, Ira; Meyer, Sheila (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 65p. (NASA-TM-X-63119; X-642-68-51). CFSTI.

The new Stellar Opacity program, "STOP" is described. "STOP" is the FORTRAN version of the IBM 7090 FAP, "OPACITY" and "IONIC" programs developed by Dr. Arthur N. Cox at the Los Alamos Scientific Laboratory. A Rosseland Mean Continuous Opacity is computed and the following processes are included: Bound-free and free-free absorptions including those of the ^2H ion, Compton electron scattering, H_2 and H + H molecular absorptions, and electron conduction. Equations used for these processes as well as the "Mayer Independent Electron" and "Ionic" methods of computing occupation numbers and other equation of state data are discussed. "STOP" is available for general usage. (auth) (STAR)

38656 (N-68-18173) PRIMORDIAL HELIUM AND THE LUMINOSITY OF HORIZONTAL-BRANCH STARS. Sugimoto, Daiichiro; Asano, Naruyoshi (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 17p. (NASA-TM-X-63109; X-641-68-42). CFSTI.

The discovery of the 3°K cosmic black-body radiation has provided compelling evidence for element synthesis in a primordial fireball. In particular, the primordial helium abundance by mass, $Y = 0.27$ should therefore be found in present-day population-II stars. The confirmation of the existence of the primordial helium is considered. It is well known that the direct determination of helium abundances is difficult, especially in the population-II stars. The indirect approach of comparing theoretical stellar models with observation also leads to difficulties, since in many cases the stellar evolution depends upon the stellar mass, which is often observationally uncertain. The approach involves the latter method, but considers only certain types of stars whose absolute magnitudes are insensitive to the stellar mass, viz., horizontal-branch stars in globular clusters and field RR Lyrae stars. (auth) (STAR)

38657 (N-68-19136) SOLAR SPIN DOWN AND NEUTRINO FLUXES. Ezer, Dilhan; Cameron, A. G. W. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). Mar. 1968. 9p. (NASA-TM-X-60923). CFSTI.

It is suggested that the failure of Davis to detect a flux of ^8B neutrinos from the sun may result from the maintenance of a high central hydrogen abundance. This could arise from the circulation currents associated with the spin down of a fast rotating core. On this basis a lower limit to the flux is predicted which is about the same as Davis' upper limit. (auth) (STAR)

38658 (N-68-20085) THEORETICAL STUDY OF THE MAGNETIC FIELD IN THE LUNAR WAKE. Whang, Y. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1968. 29p. (NASA-TM-X-63150; X-612-68-17). CFSTI.

When the solar wind interacts with the Moon, the plasma shadow region on the dark side of the Moon forms a long lunar wake. In the plasma umbra a detectable plasma flow is absent; and in the penumbra the plasma flux increases from the void condition in the umbra to the interplanetary condition outside. A theoretical model for perturbations of the magnetic field in the plasma shadow is studied by directly solving Maxwell's equations for steady state solutions. The perturbation of the field is assumed to be due to the magnetization current, the gradient drift current and the curvature drift current. Numerical solutions are obtained to describe the variations of the magnetic field. The results obtained are in good agreement with experimental observations from the Explorer 35 satellite. (auth) (STAR)

38659 (N-68-20484) PHOTOMESON PRODUCTION BY THE UNIVERSAL MICROWAVE THERMAL RADIATION FIELD AND THE HIGH-ENERGY COSMIC RAY SPECTRUM. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 12p. (NASA-TM-X-63145; X-641-68-69). CFSTI.

A reexamination of the effect of photomeson production by the universal microwave thermal radiation on the cosmic-ray spectrum above 10^{11} GeV leads to the conclusion that the cosmic-ray spectrum may not steepen abruptly above that energy as previously thought. The production of high energy mesons resulting from the interaction of cosmic-rays with low energy photons results in two effects of astrophysical interest. As was pointed out by Hayakawa, the resultant photoproduction of neutral pions yields gamma rays having energies greater than 10^8 GeV whose flux may be more intense than the gamma-ray flux from cosmic-ray proton–proton collisions. (auth) (STAR)

38660 DETERMINATION OF THE MEAN POPULATION OF CLUSTERS OF GALAXIES. Kalinkov, M.; Rakova, S. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 99-101(1968).

The most important results of the calculation of the autocorrelation functions for statistical series formed by the number of galaxies in the squares $3' \times 3'$ or $(6' \times 6')$ on print PA 83 (Palomar Atlas) are given. Unpublished counts of Veleva and Kalinkov were used. (W.D.M.)

38661 PHOTOELECTRIC AND SPECTROSCOPIC OBSERVATIONS RELATED TO A POSSIBLE OPTICAL COUNTERPART FOR PULSAR CP 1919 + 21. Lynds, R.; Maran, S. P.; Trumbo, D. E. (Kitt Peak National Observatory, Tucson, Ariz.). Science, 161: 42-3(July 5, 1968).

Spectroscopic observations of the two stars near the pulsar CP 1919 + 21 are not sufficiently conclusive to permit an identification of either object with the source of the radio pulses. However, the most extensive series of photometric observations of a region of sky near the radio source position, which region includes the brighter of the two stars, suggests an approximately sinusoidal variation. It is significant that the period of the variation is double the period of the radio pulsations. (auth)

38662 PULSARS: OBSERVATIONS OF SPECTRA. Goldstein, R. M. (California Inst. of Tech., Pasadena). Science, 161: 44-5(July 5, 1968).

Dynamic spectrograms of two of the recently discovered pulsating radio sources were obtained. The data provide the instantaneous spectrum and the time-frequency history of the signals over a bandwidth of 3 MHz. (auth)

38663 STELLAR ROTATION. Epps, Harland W. (Univ. of California, Los Angeles). Proc. Nat. Acad. Sci. U. S., 60: 51-8(May 1968).

A perturbation technique is described for approximating the internal structure of rotationally distorted stars. (M.O.W.)

38664 COSMOLOGICAL RED-SHIFT LAW FOR RADIO GALAXIES AND QUASI-STELLAR RADIO SOURCES. Gomide, F. M. (Instituto Tecnologico de Aeronautica, Sao Jose dos Campos, Spain). An. Acad. Brasil. Cienc., 39: 405-11(Dec. 31, 1967).

Certain objections are raised as to the validity of the evolutionary cosmological models on theoretical and observational grounds. The probable presence of obscurating intergalactic matter pointed out by Zwicky, suggests the utilization of radio magnitudes of optically identified radio sources to test the red shift-magnitude relation. In order to by-pass observational selection a suggestion is proposed, to wit: statistics of red shift-radio magnitude data for groups of objects with about the same red shifts, with magnitudes defined in the system of the brightest. For radio galaxies results seem to favor the static de Sitter world-model. The somewhat different result for quasi-stellar radio sources may be perhaps an indication that the red shifts of these objects are not entirely of cosmological origin. (auth)

38665 PHASE INTEGRALS IN PULSATION THEORY OF VARIABLE STARS. de Freitas Pacheco, J. A. (Instituto Tecnologico de Aeronautica, Sao Jose dos Campos, Spain). An. Acad. Brasil. Cienc., 39: 413-19(Dec. 31, 1967).

A method of calculus of the pulsation constant Q, in the pulsation theory of variable stars, is discussed through the calculus of the system phase integrals. (auth)

38666 THE DOPPLER EFFECT AND ITS DISPLACEMENT TOWARD THE RED IN RATIONAL MECHANICS: APPLICATIONS AND EXPERIMENTAL VERIFICATIONS. Loiseau, Jean. Appl. Opt., 7: 1391-1400(July 1968). (In French).

Shifts z and z′ toward the red of the galaxy NGC 5668 for a beam of 21 cm, z measured in radioastronomy with a frequency meter and z′ measured in optics with a spectrograph, not being equal, it follows that the speed of light from a galaxy $\bar{c}'$ is not equal to that of a galaxy c which is measured on Earth from a stationary source. The Doppler empirical formula cannot be explained in classical mechanisms since it is in contradiction with it. As for the theory of relativity $\bar{c}' = c$ from a postulate and $z' = z$. If one considers the Universe represented on a three-dimensional space (H), non-Euclidian, with Euclidian connection plunged in a Riemannian four-dimension space (E), a certain universal time, like that of an astronomer, can be defined and its course calculated in relation to this time: it will necessarily be confounded with the atomic clock time, but $\bar{c}' \neq c$ and $z' \neq z$: the Doppler formula is not accurate. However, $\bar{c}'$ and c as well as z′ and z are so close in all the experiments carried out on Earth, even, when an artificial satellite is used, that the errors made in using the Doppler formula are clearly inferior to experimental errors. (auth)

38667 PULSAR Io EFFECT. Douglas-Hamilton, D. H. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 218: 1035(June 15, 1968).

It has been suggested that a small orbiting companion of a neutron star might trigger pulses of radio emission, in a way analogous to the Io effect in Jupiter. A satellite of mass $m < 10^{27}$g was proposed, to avoid difficulties with gravitational radiation, orbiting at $R = 10^{8}$cm to give a period of the order observed in pulsars. This suggestion is discussed, and it is concluded that any orbiting mechanism for pulsars appears to be excluded, unless Bondi's suggestion of nonradiating states in free-fall motion is accepted. (UK)

38668 ^{244}Pu IN THE EARLY SOLAR SYSTEM. Reynolds, J. H. (Univ. of California, Berkeley). Nature (London), 218: 1024-8(June 15, 1968).

Agreements between the plutonium-244/xenon and iodine-129/xenon decay intervals for achondritic meteorites could confirm the suggestion that these two extinct radioactivities were synthesized in the galactic nucleosynthesis process. (auth) (UK)

38669 OBSERVATIONS OF PULSATING RADIO SOURCES AT 11 cm. Daintree, E. J.; Davies, J. G.; Horton, P. W.; Walsh, D. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 218: 1035-6(June 15, 1968).

Studies at 11 cm were extended to the four known pulsars. Observations were made with the Mark 2 telescope at 2,695 MHz in May 1968. Pulses were clearly detected from CP 0950 and 1133. Their arrival times agreed with those expected from comparison with observations at 408 MHz using established dispersion delays. For CP 0834 and 1919 only upper limits could be placed on 11 cm emission. Data are given for peak flux density and mean pulse energy, and results are discussed. (UK)

38670 INTERSTELLAR MAGNETIC FIELD. Roger, R. S. (Dominion Radio Astrophysical Observatory, Penticton, Can.); Shuter, W. L. H. Nature (London), 218: 1036(June 15, 1968).

An upper limit of $< 2 \times 10^{-7}$ gauss to the interstellar magnetic field in the direction of the pulsar CP 0950, derived from Faraday rotation measurements, has been reported (Smith, Nature 218: 325 (1968)). This value, for a component directed towards the Earth, is much lower than previous estimates. It is also noted that the contribution to the total rotation from the Earth's ionosphere implied by this limit is considerably lower than would be expected for the local time of the observations. In the present communication it is suggested that the observations are compatible with an interstellar field component of about 10^{-6} gauss, directed towards the source and with a larger rotation contribution from the ionosphere. It seems reasonable to conclude that the total rotation of +4 radians observed by Smith could be made up of +12 radians in the ionosphere and −8 radians in interstellar space. This interpretation is consistent with the observation that the total radiation was in the same sense as the ionospheric contribution, and implies an interstellar magnetic field four times larger than Smith's upper limit. (UK)

38671 PRELIMINARY RESULTS OF PULSATING RADIO SOURCES. Grueff, G.; Roffi, G.; Vigotti, M. (Univ. of Bologna). Nature (London), 218: 1036-7(June 15, 1968).

A programme of observations of pulsars has been started at 408 MHz using the N−S arm of the Northern Cross radiotelescope. The long transit time (4 min) in the antenna fan beam allows observation of hundreds of pulses at each transit, and the multi-beam arrangement enables rapid and precise determination of declination. Sources CP 0950, 1133 and 1919 have so far been observed, but not CP 0834. Values of δ are tabulated. A significant difference was apparent between the behavior of CP 1919 and that of CP 1133 and 0950 with regard to the pulse height in a train of pulses. CP 1919 showed trains of pulses all having almost the same height, whereas the other two sources showed a succession of markedly different pulses. An attempt was made to find some sort of correlation between the peak values of the successive pulses of a given source. CP 1919 and 0950 gave no indication of significant deviation from a sequence of random values, but CP 1133 showed some sort of regular pattern, consisting of a fluctuation of the average pulse height with a period twice that of the pulse repetition. A preliminary value obtained for the ratio between the average peak value of "even" pulses and that of "odd" pulses was 1.50 ± 0.18. This modulation would support the concept of "something" oscillating both in the fundamental mode and in some higher order mode. (UK)

38672 GRAVITATIONAL REDSHIFT AND QUASI-STELLAR OBJECTS. Hameen-Anttila, K. A. (Univ. of Oulu, Finland). Nature (London), 218: 1040-1(June 15, 1968).

The chief criticism of the gravitational interpretation of the red shift in the spectra of quasars is concerned with three aspects — high electron density, differential gravitational red shift, and the small thickness of the line-emitting layer. There are some phenomena suggesting that quasars are not at cosmological distances, and it is interesting to try to construct models in which difficulties imposed by gravitational red shift are avoided. The model studied by Greenstein and Schmidt (Astrophys J. 140 : 1 (1964)) is modified by assuming that quasars are relatively cool bodies having eruptive atmospheres, the eruptions rising radially from the surface and then falling back. If the surface temperature is sufficiently low the entire observed spectrum originates in the eruptive layer in which rapid nonthermal particles and gas masses penetrating each other give an impression of high electron temperature. The thickness of the emitting layer ΔR is then determined not by ionization and excitation but by the average height to which the eruptions are able to rise. It is assumed that gravitation is the main factor determining this height. An order-of-magnitude estimate for ΔR is obtained from the general relativistic equations of geodesics in Schwarzchild's exterior metric. The gravitational line broadening is independent of red shift and proportional to the square of the Doppler broadening. If the latter is responsible for the observed line widths, the gravitational line broadening will be quite small, and the differential gravitational red shift does not introduce any difficulties. Using the modified

model the distance and physical parameters of 3C 273 are calculated. It is found that almost the whole red shift has a gravitational origin, and the mass suggests a relationship with galaxies. (UK)

38673 POSSIBLE INTERPRETATION OF PULSES FROM A RADIO SOURCE. Kundu, M. R.; Chitre, S. M. (Tata Inst. of Fundamental Research, Bombay). Nature (London), 218: 1037-8 (June 15, 1968).

Pulses have been recorded by the Cambridge group from a local object, lasting for about 0.016 sec and repeating with extreme regularity with a period of 1.337 sec. The amplitude of the pulses varies randomly, the pulses appearing and disappearing for periods of a few minutes. There is also a fine structure superimposed on the main pulse. Despite the regularity of the pulses the power emitted varies significantly over all periods, and observations indicate a frequency drift of -5 MHz/sec. The absence of any proper motion of the source, and interpretation of the frequency drift in terms of dispersion through the interstellar plasma, limit the distance of the source to the range 10^3 A.U. $< d < 65$ pc. From the pulse width and the rate of frequency drift the source is smaller than 5×10^8 cm. It has been suggested that the radio signals come from a pulsating neutron star or a white dwarf. The possibility of coherent plasma oscillations has also been suggested; also that the periodicity of the pulses could arise from the rotation of a binary system of neutron stars, the gravitational lens effect focusing the radio waves during the rapid rotation. An attempt is made to account for the impulsive radiation in terms of plasma oscillations originating in the magnetosphere of a neutron star. The fine structure that is often superimposed on the main pulse is reminiscent of repeated excitations of plasma waves. During each vibration of the star hydromagnetic shock waves will be set up, and particles released as a result of field pinches will be accelerated; these particle streams or the shock waves may excite the plasma oscillations. Synchrotron radiation cannot account for the pulses, since in a high magnetic field such as exists in a neutron star the radiation would be damped out in a small fraction of a second. With regard to the observed frequency drift from high to low frequencies, it seems difficult to explain the large variation of drift rate on the basis of dispersion through the interstellar plasma; part of the dispersion probably arises in the source itself. The frequency drift may be the result of an exciting disturbance passing through different plasma levels in the star's atmosphere. The fine structure could be caused by repeated pinches which might occur each time the plasma oscillations are excited. It is tempting to suggest that the pulses are similar to solar bursts of type 3 or 1. The energy requirements for such a model are adequately satisfied because of the high energies involved in the vibrational modes. The observed linear polarisation may be caused by the existence of a polarisation limiting region in the star's outer magnetosphere, and it may be assumed that circular polarisation is initially imposed on the radio waves as a result of selective absorption of the extraordinary magnetoionic mode. (UK)

38674 CONFIRMATION OF THE PARKES PERIOD FOR CP 1919. Zeissig, G.; Richards, D. W. (Cornell-Sydney Univ., Arecibo, Puerto Rico). Nature (London), 218: 1037 (June 15, 1968).

A measurement of the period of CP 1919 by Radhakrishnan et al. (Nature 218: 229 (1968)) disagreed with the value obtained at Cambridge (Parkes) by about 21 μs. With a view to resolving this discrepancy the present authors calculated a period from observations made at Arecibo in March 1968, close to the dates of the Parkes observations. Results agree closely with the Parkes number. The observations were made at 111.5 MHz. Doppler shift corrections were taken into account. (UK)

38675 TIME-DEPENDENT INTERNAL SOLUTIONS FOR SPHERICALLY SYMMETRICAL BODIES IN GENERAL RELATIVITY. II. ADIABATIC RADIAL MOTIONS OF UNIFORMLY DENSE SPHERES. Thompson, I. H.; Whitrow, G. J. Mon. Notic. Roy. Astron. Soc., 139: 499-513 (1968).

A differential equation is derived for the radius of a spherically symmetrical body of uniform density as a function of time t, for any arbitrary equation of state of the material at the center, the equation of state elsewhere being determined by that at the center through the condition $\rho = \rho(t)$. This differential equation can be applied to cases where the body may oscillate or continually contract or expand. In Paper I of this series (Mon. Not. Royal Astr. Soc., 136, 207 (1967)) the possibility of asymptotic contraction to a radius $R > 9GM/4c^2$, where M is the mass, was overlooked. If, however, a stage is reached for which $R < 9GM/4c^2$, collapse to zero volume must occur. The analysis is applied to bodies in which the material at the center obeys a polytropic equation of state and general formulae are obtained for determining the radial motion uniquely for any polytropic index and initial conditions. (auth) (UK)

38676 SOLAR GRANULATION. Bray, R. J.; Loughhead, R. E. The International Astrophysics Series. Volume Eight. New York, Barnes and Noble, Inc., 1967. 164p. $9.50.

Granulation is basically a convection phenomenon; each granule and its surrounding dark material representing a single convection cell. In order to provide a proper basis for interpreting its properties, detailed consideration is given to modern hydrodynamic theories of fluid convection. Although primarily written to give solar physicists the first detailed account of granulation, this book should provide astrophysicists with the necessary observational basis for improving the theory of convection under the conditions prevailing in stars. Topics covered include: historical introduction; morphology, evolution, and dynamics of photospheric granulation; sunspot umbra granules, facular granules, and supergranulation; convection theories of the origin of granulation; and current development in high-resolution observing methods. (W.D.M.)

38677 CONDENSATION OF DUST IN GALACTIC EXPLOSIONS. Hoyle, F.; Wickramasinghe, N. C. (Univ. of Cambridge, Eng.). Nature (London), 218: 1126-7 (June 22, 1968).

The possibility that large quantities of solid particles with sizes of the order of the wavelength of light may form in explosions of massive objects in the nuclei of galaxies was investigated. (auth) (UK)

38678 THE CN RED SYSTEM IN THE SOLAR SPECTRUM. Lambert, D. L. (Oxford Univ., Eng.). J. Quant. Spectrosc. Radiative Transfer, 8: 1265-79 (June 1968).

The relative band oscillator strengths for nine vibrational bands of the CN red system are derived from equivalent width measurements of CN lines in the solar spectrum. The variation of the electronic transition moment is deduced and shown to be in good agreement with the variation determined from laboratory measurements of the radiative lifetimes. The importance of using RKR rather than Morse potential computations is stressed. The recommended relative and absolute band oscillator strengths are presented. A method for the rapid estimation of the equivalent widths of CN lines in the solar spectrum is given. (auth) (UK)

38679 PROPERTIES OF HIGH-DENSITY MATTER IN INTENSE MAGNETIC FIELDS. Chiu, Hong-yee; Canuto, Vittorio (Goddard Space Flight Center, New York). Phys. Rev. Lett., 21: 110-13 (July 8, 1968).

Recent results on the properties of matter in intense magnetic fields which are believed to exist in gravitationally collapsed bodies are summarized. The equations of state of a Fermi gas in magnetic fields are presented; they are superpositions of quantities relevant to a one-dimensional gas if the density is low enough or the field strong enough. For laboratory matter, the transition field is approximately 10^9 G. (auth)

38680 PHOTOMETRIC INVESTIGATION OF THE SCORPIO-CENTAURUS ASSOCIATION. Gutierrez-Moreno, Adelina; Moreno, Hugo (Univ. of Chile, Santiago). Astrophys. J., 15: Suppl. Ser. 140, 459-98 (June 1968).

UBV colors and magnitudes are given for 251 stars in the region of the Scorpio–Centaurus association. Intrinsic colors and magnitudes corrected for interstellar absorption are computed by Johnson's Q method. The presence of strong differential reddening in a restricted area permitted an estimation of the ratio of total to selective absorption, which seems to be abnormally high for this zone. Absolute magnitudes were computed using moving cluster parallaxes. Luminosity calibration curves against both colors are given for all stars with known distance moduli. A study of the possible membership of the association is made for all program stars. Hβ observations were made for all stars brighter than 6.5 which were retained as members or probable members from three-color photometry; using Hardie and Crawford's calibration, new distance moduli were determined from the β values. The group has an elongated shape, making an angle of about 18° with the galactic plane. (auth)

38681 RESULTS OF SPACE RESEARCH: SOLAR X RAYS. TRW Space Log, 7: 88-93 (Winter 1967-8).

Satellite studies of solar x-ray flares are reviewed. The rise and fall of x-ray emissions from the Sun correlate closely with flares as detected by CaK plage areas, Lyman-alpha emission, and decimetric radio wave emission. The Solrad 7A satellite found an 85% correlation between x-ray emission at 44 to 60 Å and 10.7-cm radiation. X-ray emission varies substantially as a function of wavelength. The OSO 2 and the Solrad series showed that x-ray flares as determined by radiation below 20 Å are often accompanied by no change, or even a decrease, in the flux at 44 to 60 Å. Such behavior appears to be typical of small flares, when the x-ray emission below 20 Å is confined to a small portion of the solar disk. The sources of x rays of shorter wavelength are in general smaller than those of longer wavelength. Some 8 to 15 Å sources

have dimensions of 1 min of arc or less. All sources of x rays below 20 Å are colocated with active sunspot regions; about half of the 44 to 60 Å emission is localized in the same regions, the remainder being distributed over the disk. These observations have verified existing theory for stellar origins of x rays and have contributed to the eventual quantitative understanding of the sources of energy within the Sun. The theory predicts that microwaves and x rays are both emitted by the thermal conditions found on the Sun. The million-degree temperatures in the lower corona in particular lead to a prediction of x rays from this source and of the limb brightening that has been observed at these wavelengths. The association of x rays with flares is also predictable; atoms bombarded with energetic electrons can be ionized by the loss of a K-shell electron, and the subsequent release of energy as an outer electron fills the K-shell can be in the form of an x-ray photon. Such characteristic x rays appears to form a large part of the emission from flares. (BBB)

38682 DYNAMICAL TIDES IN CLOSE BINARY SYSTEMS. III. DISSIPATION OF ENERGY. Kopal; Zdenek (Univ. of Manchester, Eng.). Astrophys. Space Sci., 1: 411-23(June 1968).

The circumstances are investigated under which an irreversible dissipation of the kinetic energy into heat is generated by the dynamical tides in close binary systems if (a) their orbit is eccentric; (b) the axial rotation of the components is not synchronized with the revolution; (c) the equatorial planes are inclined to that of the orbit. The explicit form of the viscous dissipation function is set up in terms of the velocity-components of spheroidal deformation arising from the tides; the principal partial tides contributing to the dissipation is detailed; the extent of stellar viscosity—both gas and radiative is determined; quantitative estimates are given of the actual rate at which the kinetic energy of dynamical tides gets dissipated into heat by viscous friction in stellar plasma. The results disclose that the amount of heat produced per unit time by tidal interaction between components of actual close binaries equals only about 10^{-10}th part of their nuclear energy production; and cannot, therefore, affect the internal structure of evolution of the constituent stars to any appreciable extent. Moreover, it is shown that the kinetic energy of their axial rotation can be influenced by tidal friction only on a nuclear, rather than gravitational (Kelvin) time-scale—as long as plasma or radiative viscosity constitute the sole sources of dissipation. However, the emergence of turbulent viscosity in secondary components of late spectral types, which have evolved away from the main sequence, can accelerate the dissipation 10^5 to 10^6 times, and thus give rise to appreciable changes in the elements of the system (particularly in the orbital periods) over time intervals of the order of 10^5 to 10^6 years. Lastly, it is pointed out that, in close binary systems consisting of a pair of white dwarfs, a dissipation of the kinetic energy through viscous tides in degenerate fermion-gas could produce enough heat to account, by itself, for the observed luminosity of such objects. (auth)

38683 RADIATIVE SOURCE-FUNCTION PREDICTIONS FOR FINITE AND SEMI-INFINITE NONCONSERVATIVE ATMOSPHERES. Heaslet, Max. A.; Warming, R. F. (Ames Research Center, Moffett Field, Calif.). Astrophys. Space Sci., 1: 460-98 (June 1968).

The probabilistic method of Sobolev and Case's method of normal mode expansion are combined to predict source-function distributions for radiative transfer in nonconservative, plane-parallel atmospheres. The solutions obtained for semi-infinite atmospheres are exact and can be expressed in terms of functions and parameters associated with the nonconservative Milne problem. The predictions for finite atmospheres are approximate and are constructed from the semi-infinite solutions. Tabular values of the requisite functions and parameters are provided to facilitate rapid numerical evaluation of the solutions. Although the finite solutions correspond to the zeroth-order (optically thick) approximation by Case's method, an assessment of the accuracy indicates that the results are useful for optical thicknesses as small as one or even less. The close connection between the results obtained and the method of point-direction gain of Van de Hulst is discussed. (auth)

38684 SOME WEAK INTERACTION PROCESSES IN HIGHLY-EVOLVED STARS. Hansen, Carl J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. Space Sci., 1: 499-512 (June 1968).

Some weak interaction processes which are important in stars whose central temperatures and densities exceed $10^{9\circ}$K and 10^6 gm/cm^3 are discussed. Simple analytic expressions for reaction rates which are convenient for computer studies of the late stages of stellar evolution are given. (auth)

38685 EXCESS ^{128}Xe IN METEORITES. Rao, M. N.; Clark, R. S.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Astrophys. Space Sci., 1: 513-18(June 1968).

Using known compositions of primordial and spallation xenon components in several meteorites, the neutron produced ^{128}Xe has been resolved. For obtaining the value for spallation produced $(^{128}Xe/^{130}Xe)_c$, the meteorites with low iodine content and high-spallation contribution are considered. Using these data, the neutron densities in several meteorites due to cosmic-ray exposure are calculated and their significance is qualitatively discussed. (auth)

38686 ON THE X-RAY SOURCE SCO X-1. Vilhu, Osmi; Tuominen, Ilkka V. (Univ. of Helsinki). Astrophys. Space Sci., 1: 424-8(June 1968).

If the assumption of a catastrophic explosion during the formation of a neutron star is correct, the parent systems for Sklovsky's model of Sco X-1 seem to have been very short-period white-dwarf binaries. A white dwarf originally in contact with its Roche limit is forced to lose mass. During the ejection of matter the primary may pass the white-dwarf mass limit and become a neutron star. The mass transfer time scale can change from pulsational to thermal, and a mass flow of 10^{-9} $M_\odot$ per year needed for Sco X-1 can be understood, while at the same time the orbital period will increase. (auth)

38687 ISENTROPIC MODELS FOR FINAL STAGES OF STELLAR EVOLUTION. Rakavy, G.; Shaviv, G. (California Inst. of Tech., Pasadena). Astrophys. Space Sci., 1: 429-41 (June 1968).

Using isentropic and homogeneous stellar models the final stages of stellar evolution are discussed. These primitive models are a natural generalization of polytropic models to cases of complex equations of state. The equations of state used in the present work include the effects of radiation, quantum degeneracy, relativistic electrons and pairs, and of a Fe–He transition. A limiting mass–entropy relation is discussed. This relation is a direct generalization of Chandrasekhar's limiting mass for white dwarfs, and is useful for obtaining a general picture of the evolutionary tracks at late stages. Tracks of central conditions on the p, T plane are calculated for isentropic models and the occurrence of various instabilities is discussed. (auth)

38688 THE de SITTER UNIVERSE AND MACH'S PRINCIPLE. Inomata, Akira (State Univ. of New York, Albany). Progr. Theor. Phys. (Kyoto), 39: 1370-2(1968).

In order that a curved Universe be in accordance with Mach's principle in Einstein's sense, it would have to be required that a matter distribution be essential to its nonflatness. It is the purpose of the present note to make a previous result consistent with this requirement, thus proposing a de Sitter Universe responsible for Mach's principle. (W.D.M.)

38689 EVOLUTION OF A ROTATING GAS CLOUD. Ireland, J. G. (Royal Observatory, Edinburgh). Z. Astrophys., 68: 294-305(1968).

Observations of young early-type stars suggest that they are surrounded by gaseous envelopes of approximately similar mass. This conclusion is borne out by simple energy considerations applied to a rotating homogeneous gas cloud. If the inner part of the cloud transfers its angular momentum to the outer part by some means, then it is shown that in accordance with the observations the total cloud mass is distributed in roughly even proportions between the central mass and its surrounding envelope. (auth)

38690 CHROMOSPHERIC SPECTRUM AT THE 1962 ECLIPSE. Dunn, R. B. (Sacramento Peak Observatory, Sunspot, N. Mex.); Evans, J. W.; Jefferies, J. T.; Orrall, F. Q.; White, O. R.; Zirker, J. B. Astrophys. J., 15: Suppl. Ser. 139, 275-458(May 1968).

A joint expedition of the High Altitude Observatory, Sacramento Peak Observatory, and the National Bureau of Standards obtained slitless spectrograms of the flash spectrum at the February 5, 1962, total eclipse of the Sun. The spectrograms covered the wavelength range of about 3200 to 9100 Å with a height resolution of 100 km. The spectrographic equipment, the observations, the photometric calibration procedures, and the methods adopted to reduce the large quantity of data are described. The results are presented in a set of tables that show the wavelength and identification (where known) of each of the 3500 lines recorded. A separate set of tables lists the intensity of each line at each height. The latter tables are ordered according to the element, ionization stage, and multiplet number associated with the line. (auth)

38691 THE INTERSTELLAR LINE SPECTRUM OF ZETA OPHIUCHI. Herbig, G. H. (Univ. of California, Santa Cruz). Z. Astrophys., 68: 243-77(1968).

The optical interstellar lines in ζ Oph are double (at −15, −29 km/sec) on ordinary spectrograms. The stronger component at −15 km/sec was analyzed to obtain homogeneous data on the atomic and molecular concentrations in a specific interstellar volume. A curve of growth study yielded N, the total number of

absorbers cm^{-2} for NaI, CaII, KI, Ch, and CN (and CH^+ when an absolute f-value becomes available). Upper limits were set on CaI, FeI, TiI, TiII, and the diatomic molecules OH, NH, MgH, SiH, and CO^+. Correction of the atomic data for ionization was performed by evaluating the photoionization and recombination coefficients in the combined radiation field of ζ Oph (based on a line-blanketed photospheric model by Hickok and Morton) and that of the galaxy. Reduction of the N's to concentrations n (in cm^{-3}) was based on a model for the distribution of interstellar material between ζ Oph and the sun, beginning with an HII region of n_e = 3 cm^{-3} centered on the star. (TSS) (auth)

38692 A CURVE OF GROWTH ANALYSIS OF γ CAPRICORNI. Garcia, Z. L. (Observatorio Astronomico y Consejo Nacional de Investigaciones Cientificas y Tecnicas, La Plata). Z. Astrophys., 68: 278-93(1968).

An abundance analysis of the transition star γ Capricorni was carried out with a curve of growth technique applied to Coude material. Several abundance anomalies were found, especially overabundance of the iron peak elements. Elements heavier than Sr are also enhanced while the metals lighter than Ti are all underabundant. (auth)

38693 GALACTIC ORBITS OF OLD MOVING STELLAR GROUPS: SOME INITIAL NUMERICAL RESULTS. Innanen, K. A.; Southern, B. (York Univ., Toronto). Z. Astrophys., 68: 305-8(1968).

Results of numerical computations of past orbits of stars in three old moving groups in a galactic mass model are presented. These are the Groombridge 1830, the Kapteyn's Star, and the (U,V) = (–160,–320) groups. Although integration times extend from 5 to 12×10^9 yr, only one possible common point of origin has been found, that for Kapteyn's Star group at 4.17×10^9 years. No assurance can therefore be given that these stars form physically real groups. (auth)

38694 RATIO OF INTERSTELLAR ABSORPTION TO FADING. Grubissich, C. (Univ., Basel). Z. Astrophys., 68: 309-16(1968). (In German).

A mean extinction curve is derived from Johnson's observations of 40 strongly reddened stars of early spectral type; this curve is compared with mean extinction curves for different regions in the Milky Way. It is shown that it cannot be warranted that the value $R = A_V/E\,(B-V)$ is significantly greater than 3.0 in any region considered. (auth)

38695 UNSTABLE STATIONARY ROTATION IN STARS. Fricke, Klaus (Univ., Goettingen, Ger.). Z. Astrophys., 68: 317-44(1968). (In German).

Secular stability against meridional motions in the radiative zones of stationary rotating stars is investigated with a linear perturbation theory. For local perturbations the strong secular instability of an arbitrarily given stationary rotating stellar model is shown. The most unstable modes are growing very rapidly compared with any time-scale of evolution. The resulting irregular motions may be very important for the distribution of angular momentum over the radiative zone. For a cylindrically symmetric model the exact eigenvalue problem is solved numerically and the existence of large-scale instability is shown. (auth)

38696 SOLID HYDROGEN AND THE MICROWAVE BACKGROUND. Hoyle, F. (Cambridge Univ., Eng.); Wickramasinghe, N. C.; Reddish, V. C. Nature (London), 218: 1124-6(June 22, 1968).

The theme of this paper is that solid-state processes may be a controlling factor in the evolution of the Universe, and may account for similarities in the energy densities of several astrophysical phenomena, with particular reference to the microwave background. (auth) (UK)

38697 CRYSTALLIZATION AND TORSIONAL OSCILLATIONS OF SUPERDENSE STARS. Ruderman, M. A. (Imperial Coll. of Science and Tech., London). Nature (London), 218: 1128-9 (June 22, 1968).

Consideration is given to the possibility that neutron stars may support torsional oscillations, having periods in the lowest mode of a few tenths of a second, similar to the periods of the pulsed radio sources. Neutron star matter may contain a crystal lattice that can support transverse short waves. (auth) (UK)

38698 ON THE POSSIBILITY OF DISCOVERING PERIODICAL SOLAR MODULATIONS INDUCED BY VERTICAL MOTION IN THE CHROMOSPHERE. Yudin, O. I. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 617-18(1968). (In Russian).

Optical studies have revealed oscillatory motions only in the lower chromosphere. However, it is not excluded that they may also exist in higher elevations. (R.V.J.)

38699 GEOPHYSICAL ACTIVITY OF SOLAR FLARES AS A FUNCTION OF THE HEIGHT OF THEIR FORMATION IN THE SOLAR ATMOSPHERE. Dolginova, Yu. N.; Odintsova, I. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 779-84(1967).

Translated from Geomagn. Aeron., 7: 958-66(1967).

It is demonstrated that flares of the same intensity are manifested differently on Earth, depending on the height at which they originate in the solar atmosphere. Some flares are accompanied by sudden ionospheric disturbances, by an increase in cosmic-ray intensity, by polar-cap absorption, and by geomagnetic storms, while others are not. The height at which flares originate can be determined with great probability from the character of radio noise during the flares. (auth)

38700 RELATION OF GEOMAGNETIC ACTIVITY TO THE ENERGY FLUX DENSITY OF THE QUIET SOLAR WIND. Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 797-9(1967).

Translated from Geomagn. Aeron., 7: 982-4(1967).

The fluxes of the energy of directional motion and of thermal and electromagnetic energy incident upon the cross section of the magnetosphere were estimated from the IMP-1 data on the sector structure of the interplanetary magnetic field, which apparently represents a quiet solar wind. It is shown that the energy fluxes of each type separately are quite sufficient to produce the entire complex of geophysical phenomena during a moderate magnetic storm. The relationship between the 3-hour values of the K_p index of geomagnetic activity or their equivalent amplitudes, a_p, and the flux density of various types of energy, is examined. (auth)

38701 EXTENSION OF THE NUMBER–FLUX DENSITY RELATION FOR RADIO SOURCES TO VERY SMALL FLUX DENSITIES. Pooley, G. G.; Ryle, M. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 139: 515-28 (1968).

Observations of sources having $S_{408} > 0.01 \times 10^{-26}$ W m^{-2} Hz^{-1} made it possible to derive a new N(S) curve, where N is the number of sources per steradian observed with a flux density greater than a given value S. The results confirmed earlier observations that for $S_{408} > 4 \times 10^{-26}$ W m^{-2} Hz^{-1}, the number of sources given by $N \propto S^{-1.55}$, but for weaker sources a remarkable convergence occur; for $S_{408} = 0.01 \times 10^{-26}$ W m^{-2} Hz^{-1} the number increases only as $N \propto S^{-0.8}$. The results are related to the total emission from extragalactic space, and it is shown that this convergence must continue; Thomson scattering in the intergalactic medium cannot be responsible fot the cutoff. The observed isotropy of sources makes any non-cosmological interpretation of the source counts untenable, and the new results are compared with previous models of evolutionary cosmologies which suggest that there is a rapid cutoff in the number of radio sources occurring beyond z ~ 3 or 4. (auth) (UK)

38702 THE 5C2 SURVEY OF RADIO SOURCES. Pooley, G. G.; Kenderdine, S. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 139: 529-50(1968).

The Cambridge One-Mile Telescope was used to make a second survey of weak radio sources at 408 MHz. Over 200 sources were observed in an area 4° in diameter, with a positional accuracy of a few seconds of arc and a limiting flux density $S_{408} = 11.5 \times 10^{-29}$ W m^{-2} Hz^{-1} over the central part of the area. Eleven of the sources were also observed at 1407 MHz. Some optical identifications are suggested, including a number of normal galaxies and possible quasi-stellar sources. (auth) (UK)

38703 OPTICAL INTERSTELLAR ABSORPTION FEATURES. Buscombe, William; Kennedy, Pamela M. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 139: 417-24 (1968).

Radial velocities are presented for interstellar clouds detected in the spectra of 70 stars of early type in the southern Milky Way. Also included are equivalent widths for the H and K lines of Ca(II), the band at λ4430, the D lines of Na(I), and for a few reddened stars; also the diffuse bands in the red region. The observations were secured with a Coudé spectrograph having dispersions of 150 and 100 microns per angstrom in the violet and yellow respectively. (auth) (UK)

38704 PHOTOMETRY, KINEMATICS, AND DYNAMICS OF THE MAGELLANIC-TYPE BARRED SPIRAL GALAXY NGC 4027. de Vaucouleurs, Gerard; de Vaucouleurs, Antoinette; Freeman, Kenneth C. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc., 139: 425-59(1968).

Photometric and spectroscopic observations with the 36-in. and 82-in. reflectors were analyzed to derive a mean rotation

curve, total mass, and mass–luminosity ratio of the Magellanic-type barred spiral NGC 4027. For an estimated distance Δ = 12.5 Mpc the adopted values are $M_T = (13 \pm 3) \times 10^9$, $f_B = 1.85 \pm 0.4$ with $B_T = 11.70 \pm 0.05$, $(B-V)_T = +0.54$, $(U-B)_T = 0.03$. The mass is close to that of the Large Magellanic Cloud, but the mass–luminosity ratio is lower because of the relatively higher surface brightness of NGC 4027. The rotation curve is asymmetric with respect to the center of the bar, as previously observed in galaxies of the same type (LMC, NGC 55, 4631). A model consisting of a prolate spheroid (bar) offset from the center of a larger oblate spheroid is described; it accounts qualitatively and quantitatively for the residual velocity pattern (noncircular motions) observed in NGC 4027 and the Large Cloud. Detailed isophotometry of emission and absorption lines in the bar confirmed the previously reported evidence for large scale gas streaming away from the center and along the major axis of the bar, but it also revealed that, as theoretically predicted, the mean motion of the stars near the minor axis of the bar is in a direction opposite to that of the gas and of the figure of the bar. (auth) (UK)

38705 FORMATION OF SOLAR PROMINENCES. **Raju, P. K. (Tata Inst. of Fundamental Research, Bombay). Mon. Notic. Roy. Astron. Soc., 139: 479-97(1968).**

A nonlinear treatment of condensation of quiescent-type prominences, from the solar corona, by means of thermal instability is presented. It was found that the prominence stage was reached after times of the order of 10^6 s. The condensation process is inhibited due to heat conduction by free electrons if the initial magnetic field strength is less than 10^{-4} gauss. Magnetic fields greater than 0.1 gauss do not allow any significant density increase. However, for magnetic fields >0.1 gauss significant density increase will take place due to secondary processes after the initial (thermal instability) prominence temperature is attained. (auth) (UK)

38706 ENERGY FLUX OF THE SOLAR PLASMA IN THE SECTOR STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 794-6(1967).

Translated from Geomagn. Aeron., 7: 978-81(1967).

Average 3-hour values were computed for the flux density of the kinetic energy of directional plasma motion, q_1, and for the flux density of thermal, q_2, and electromagnetic, q_3, energies for the positive and negative sectors of the interplanetary magnetic field, observed by IMP-1 from December 1963 through February 1964. The character of the distribution of q_1, q_2, and q_3 in the sectors and their relation to the velocity of the solar plasma are discussed. It is shown that $q_1 \gg q_2 \approx q_3$ and that there is no particular difference between the sectors. The energy fluxes across the sectors are estimated. (auth)

38707 INTERPRETATION OF DATA ON THE ANGULAR DISTRIBUTION OF SOLAR-WIND IONS, OBTAINED ON PIONEER 6. Khokhlov, M. Z. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 874-6(1967).

Translated from Geomagn. Aeron., 7: 1079-80(1967).

Data are given which show that in the case in question and under the given assumptions regarding the distribution function, the temperature anisotropy with respect to the direction of the magnetic lines of force was very high (~10 to 50). This high degree of temperature anisotropy could have been reached if the process of the establishment of the anisotropy had started rather early, at least from a distance of 35 to 40 $R_\odot$ and if the role of particle scattering on magnetic inhomogeneities were sufficiently small. It should be noted that as the magnetic inhomogeneities move with the wind, the region of the spectrum of inhomogeneities, significant for scattering, narrows and the role of scattering diminishes. (W.D.M.)

38708 DIFFUSION OF SOLAR COSMIC RAYS FROM A SOURCE OF THE EXPONENTIAL TYPE. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 876-7(1967).

Translated from Geomagn. Aeron., 7: 1081-2(1967).

The dependence of the time of appearance of the maximum on the characteristic time constant, T_0, is shown. It is seen that for small diffusion coefficient, $\varkappa$, and T_0 the dependence of t_{max} on T_0 is very weak. But as $\varkappa$ and T_0 increase, t_{max} increases markedly. Thus, for example, for particles of very high energy ($\varkappa = 10^{23}$ cm^2/sec) t_{max} increases by a factor of ~10^3 when T_0 changes from 10 to 10^7 sec. (W.D.M.)

38709 ANISOTROPIC STAGE OF THE COSMIC-RAY BURST OF FEBRUARY 23, 1956. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 878-9(1967).

Translated from Geomagn. Aeron., 7: 1083-4(1967).

The angular distribution of relativistic protons with an energy $>10^9$ eV during the initial study of the cosmic-ray bursts of Feb. 23, 1956, was strongly anisotropic. At the same time, the development of the bursts in time was smooth and did not reveal any noticeable fluctuations. Therefore, the argument can be applied to this flare that relativistic protons with an energy $>10^9$ eV are scattered at small angles by inhomogeneities of the interplanetary magnetic field, and to describe the propagation of these protons use can be made of the kinetic equation in the Fokker–Planck approximation. The discussion is limited to an analysis of the average intensities of particles moving away from the Sun and toward the Sun. (W.D.M.)

38710 A MODEL FOR THE EVOLUTION OF SPIRAL GALAXIES IN THE PRESENCE OF A MAGNETIC FIELD. Uherka, Kenneth LeRoy. Lafayette, Ind., Purdue Univ., 1967. 203p.

Thesis.

There is considerable interest in the observation that most galaxies evolve into a configuration in which the gas and young stars are located in a spiral pattern. To investigate this phenomenon, the following model is adopted: first the protogalaxy is assumed to be a gas cloud in intergalactic space which underwent gravitational collapse in the presence of a weak primeval magnetic field; this results in a flattened rotating system of gas and stars. It is furthermore assumed that the uniform metagalactic field is initially inclined at an arbitrary angle to the axis of rotation and that the stellar objects constitute most of the galactic mass. A three-dimensional analytical model is then defined for times following the initial condensation period. The model analyzes the influence of magnetic forces on the evolutionary characteristics of the tenuous interstellar gas. Initially the gas motion is governed by the gravitational forces of the axially-symmetric stellar distribution, however, magnetic effects become increasingly more important due to stretching and distortion of the magnetic lines by differential rotation of the gas. Solutions of the governing dynamic and electromagnetic equations show that the forces induced through rotational distortion of the magnetic field redistribute the gas into a spiral pattern and force the gas into the equatorial plane. The theoretical results show that, for the case in which the inclination angle between the primeval magnetic field vector and the galactic rotation axis is about five degrees, the predicted spiral configuration and gas layer flatness are consistent with observations for the Milky Way. It is furthermore shown that the two limiting cases of either a two-dimensional cylinder or an infinitesimally thin disk lead to configurations which are not characteristic of spiral galaxies. The numerical values calculated for the induced motion and gas density are generally in qualitative agreement with observations, but the magnitudes differ in some cases from observed values because of the approximate nature of the model which does not account for self-gravitation of the spiral arms. (Disser. Abstr.)

38711 MODEL FOR SOLAR RADIO BURSTS WITH AN APPLICATION TO FOUR EVENTS. Barney, William Meredith Jr. University Park, Pa., Pennsylvania State Univ., 1967. 185p.

Thesis.

The purpose of the problem was to show quantitatively that the excess continuum radiation observed at the time of solar flares may be accounted for by the assumption that the radiation is due to synchrotron radiation from a distribution of relativistic electrons and to bremsstrahlung by a collection of thermal electrons contained in an expanding volume associated with the flare disturbance. In this study the detailed evolution of the spectra of four flare associated continuum radio events was studied in terms of models based on the above assumptions for generation of the radiation and the expansion of the radiation producing region. (TSS) (Disser. Abstr.)

38712 THE LAW OF INTERSTELLAR REDDENING FOR H II REGIONS AND THE Ly-V COLORS OF THEIR EXCITING STARS. Gebel, William Laurence. Madison, Wis., Univ. of Wisconsin, 1968. 86p.

Thesis.

The Hα and Hβ fluxes for 20 diffuse nebulae were measured photoelectrically with a 2″ f/3.8 telescope through interference filters of 10 Å width. The continuum radio fluxes at 6 and 11 cm for 12 of these nebulae were obtained using the 140 foot Green Bank antenna. The observational data, together with published radio continuum fluxes for the nebulae included in this study but not observed at Green Bank, were combined to deduce the total interstellar extinction from a comparison of the observed radio to Balmer flux ratios with the theoretical ratio of free–free to recombination emissivities. The color excesses for the nebulae are derived from the observed Balmer decrement. The classical result for the ratio of total to selective absorption, R = 3, is con-

firmed for the region of galactic longitude (l_{II}) 5 to 130°. In the region 130 to 210° a larger value of R is found in qualitative agreement with the galactic variation of R previously found from infrared photometry. The results for this region are the most uncertain, however, and may with improved measurements be found to agree with the classical reddening law. The reddening law for NGC 2244 is found to be normal suggesting that the reported infrared excesses for the associated stars arise from an emission process rather than from an anomalous reddening law. The ratio of emissivities is a weak function of the nebular temperature. The results reported here suggest an electron temperature of 6000°K or less for H II regions. By the Zanstra technique, a comparison between the radio fluxes of the nebulae and the apparent visual magnitudes of the associated exciting stars gives a measure of the color of the stars between the Lyman continuum and the visible. It is shown how these colors can be used to determine an effective temperature–spectral type relation for the early O stars when line blanketed model atmospheres become available. A comparison of the measured diameters of the nebulae with computed Stromgren sphere diameters shows that the nebulae excited by O5 and O6 stars with the exception of IC 1805 and the Orion nebula must absorb at least 50% of the ionizing radiation. With observed density distributions from radio contour maps, this comparison should allow the distances to the nebulae to be determined from their angular diameters and Ly-V colors. (Disser. Abstr.)

38713 SPATIO-KINEMATIC STRUCTURE OF PLANETARY NEBULAE. Weedman, Daniel Wilson. Madison, Wis., Univ. of Wisconsin, 1967. 105p.

Thesis.

Models are presented for a number of planetary nebulae in an attempt to represent both the physical distribution of emitting material and the kinematics of this material. The models are based on an analysis of the line profiles derived from high dispersion spectrograms of bright emission lines in the planetaries. These spectrograms were obtained with the 100-inch Mt. Wilson and 84-inch Kitt Peak telescopes. The planetary nebulae studied are NGC 7662, 7009, 6826, 6818, 6572, 6210, 3242, 2392, and IC 3568 and 418. The spatial models include descriptions of the shell shapes, degrees of homogeneity, and the matter distribution through the shells. The kinematic features describe the expansion velocities of different parts of the shells. It is found that ellipsoidal shells show a velocity of expansion which increases with distance from the central star, implying that the shell is now ellipsoidal because the original velocity of ejection varied with direction. The radii at different parts of a shell do not appear to be directly proportional to the expansion velocities, however, and this fact is used together with an apparent relation between a shell's thickness and its expansion velocity to infer that a long term pressure acted to eject the shell. Evidence is also presented to indicate that some planetaries consist of at least two independently ejected shells with the outer shell being more massive although appearing fainter. Of particular interest is NGC 7662. A detailed model shows the inner emitting shell to be quite thin, the thickness being about one-fifth of the radius. The gradient of expansion velocity through this shell is accurately determined, and its magnitude indicates that the observed line profiles can be explained without assuming the existence of turbulent motions within the shell. (Disser. Abstr.)

38714 AN INVESTIGATION OF THE DELTA SCUTI STARS. Millis, Robert Lowell. Madison, Wis., Univ. of Wisconsin, 1968. 170p.

Thesis.

The results of a search for short-period variability among the brighter late A and early F giants and subgiants are presented. Of the fifty-nine field stars observed, at least 15% are short-period variables. The new discoveries show that this type of behavior occurs in stars covering a larger range in spectral type, color, amplitude, period, and rotational velocity than was originally believed. The blue boundary of the Delta Scuti zone has been extended almost to the main sequence. Evidence is given for the existence of a sharp boundary on the red side of the zone at B-V = +0.35 mag. Periods as short as 50 min, amplitudes as small as 0.015 mag, and values of v sin i as large as 150 km/sec are found to occur in these stars. A few nonvariable stars were found which definitely fall among the variables in the color–magnitude diagram. These stars are all rapid rotators. A solar motion solution based on all known Delta Scuti stars except cluster members was made. The solar drift velocity and apex derived are typical of members of the older Population I. It is shown that the previously published high drift velocity derived for the dwarf cepheid variable stars is caused entirely by the effect of one star on the solution. A distinction between the dwarf cepheids and the Delta Scuti stars is therefore not possible on this basis. In addition to the field stars, thirteen members of the Hyades cluster were observed for short-period variability. Two stars, HR 1351 and 97 Tau, are almost certainly variable. From this it could be inferred that at least some of the Delta Scuti stars are in an early post-main sequence evolutionary phase. Spectral scans of the continuum between λ3250 and λ4656 and the Balmer line Hβ were made for a selection of stars — both variable and nonvariable — in the Delta Scuti region of the color–magnitude diagram. These scans are compared with the predictions of Mihalas's Balmer-line-blanketed model atmospheres to obtain effective temperatures and surface gravities for the stars. Using the best available absolute magnitude determinations, the masses of these stars were computed. (Disser. Abstr.)

38715 DISCRETIZATION OF THE DISTANCES TO QUASARS. Kalinkov, M. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 95-8(1968).

The discovery of a new effect, the discretization of the red displacements for clusters of galaxies, makes it possible to apply a method of checking cosmological models by means of observation, regardless of the methods known so far. If discretization exists, the adoption of a cosmological hypothesis regarding quasars makes their application most convenient. Certain preliminary considerations about the stationary character of the Universe were given previously, where investigation of the Wilson formula and the statistical testing of the known redshifts suggest a local uniformity and isotropicity of the Universe. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 38178, 39022, 39092, and 39224.

38716 (AD-664135) GUIDING OF SELF-FOCUSED RELATIVISTIC ELECTRON BEAMS. Roberts, Thomas G. (Army Missile Command, Redstone Arsenal, Ala. Physical Sciences Lab.). Oct. 31, 1967. 44p. (RR-TR-67-16). CFSTI.

The magnetic field of a conventional linear pinched argon plasma was used to guide a self-focused intense beam of relativistic electrons. A 30-nsec, 30,000-amp pulse of 3.5 MeV electrons was extracted from the electrode space of a flash x-ray machine and injected into the end of a cylindrical plasma column. The plasma column contained a 90-deg bend on a radius of 15 cm and the high-energy electron beam was guided around this curve without becoming defocused and without causing the plasma column to become unstable. (auth) (USGRDR)

38717 (COO-323-17) PROGRESS REPORT [ON IONIZATION OF GASES AND AVERAGE ENERGY TO MAKE AN ION PAIR]. (Saint Procopius Coll., Lisle, Ill.). June 21, 1968. Contract AT(11-1)-323-17. 15p. Dep. CFSTI.

Research work on the isotope effect in the ionization of gases by alpha particles is discussed. Some results are given for methane. Work on calibration of ionization chambers is also briefly described. (M.O.W.)

38718 (JINR-P14-3809) ISSLEDOVANIE OSTATOCHNOI POLYARIZATSII OTRITSATEL'NYKH MYU-MEZONOV V UGLEVODORODAKH. (Studies on the Residual Polarization of Negative μ Mesons in Hydrocarbons). Evseev, V. S.; Roganov, V. S.; Chernogorova, V. A.; Myasishcheva, G. G.; Obukov, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 4p. (In Russian). Dep.

In order to verify the effect of the chemical bond or structural features of condensed media on the residual polarization P_μ by the spin precession method of μ^- mesons in a magnetic field, the asymmetry coefficient $\underline{a} \approx P_\mu$ in the angular distribution of μ^- decay electrons was measured for graphite and certain hydrocarbons, such as styrene, polyethylene, cyclohexane, paraffin, phenylcyclohexane, benzene, polystyrene, and toluene. The experiments involved measurement of the electron counts of μ^- decay as a function of time since the stoppage of the muon in the target. It was found that the $\underline{a}$ values of hydrocarbons were less than half of that of graphite. This may be due to the introduction of C into the chemical bond or to the change of the structure of the materials. It is of interest to note that the P_μ value changes suddenly when going from the monomer to the polymer (styrene 3.68 ± 0.18; polystyrene 2.22 ± 0.27). (TTT)

38719 (INP-601/PS) INVESTIGATION OF WATER MOLECULES DYNAMICS IN CRYSTALLO-HYDRATES BY INELASTIC NEUTRON SCATTERING. Bajorek, A.; Janik, J. A.; Janik, J. M.; Natkaniec, I.; Parlinski, K.; Pokotilovskij, J. N.; Sudnik-Hrynkiewicz, M.; Komarov, V. E.; Ozerov, R. P.; Solovev, S. P. (Institute of Nuclear Physics, Krakow (Poland)). Apr. 1968. 37p. Dep.

Translatory and rotatory frequencies of water of crystallization

molecules were determined by the inelastic neutron scattering method in several crystallo-hydrates. The results were compared with those obtained from IR and NMR experiments. (auth)

38720 (N-68-17409) ENERGY AND WIDTH MEASUREMENTS OF LOW-Z PIONIC X-RAY TRANSITIONS. Harris, R. J. Jr.; Shuler, W. B.; Eckhause, M.; Siegel, R. T.; Welsh, R. E. (College of William and Mary, Williamsburg, Va.). [1967]. 11p. (NASA-CR-93190; WM-11). CFSTI.

New measurements have been performed of the energies and natural line widths of 2p−1s pionic x-ray transitions, as well as muonic transition energies, in ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, and ^{12}C. High-resolution Si(Li) and Ge(Li) spectrometers were used, resulting in a more precise determination than previously reported of the transition energies and natural line widths. Comparison of the measured complex energy shifts in the pionic transitions has been made with the theory of the Ericsons and good agreement found. (auth) (STAR)

38721 (N-68-18125) DIELECTRONIC RECOMBINATION. 1. THEORY. Shore, Bruce W. (Harvard Coll. Observatory, Cambridge, Mass.). Oct. 1967. 46p. (NASA-CR-93359; SR-22). CFSTI.

Dielectronic recombination (inverse autoionization) is treated as a special example of a resonance collision process; quantum scattering theory is used to parameterize the appropriate cross section for resonance capture, with particular attention to overlapping levels, degeneracy, and the complete specification of angular momentum structure. (auth) (STAR)

38722 (N-68-18121) CALCULATION OF IONIZATION EQUILIBRIA FOR OXYGEN, NEON, SILICON, AND IRON. Allen, John W.; Dupree, Andrea K. (Harvard Coll. Observatory, Cambridge, Mass.). Nov. 1967. 40p. (NASA-CR-93358; SR-24). CFSTI.

Ionization by electron collision, excitation by autoionizing levels by electron collision, dielectronic recombination, and radiative recombination are discussed in relation to the calculation of ionization equilibria for iron, neon, oxygen, and silicon; and effects of these processes upon the maximum abundance of an ion and the temperature required for ion production are considered. For most of the heavy ions or for those occurring at high temperatures, it is not necessary to consider effects of increased density; and when ionization is by electron impact from the ground state, a density independent solution appears to be adequate. (STAR)

38723 (N-68-19039) VARIATIONAL BOUNDS IN POSITRON ATOM SCATTERING. Drachman, Richard J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1968. 57p. (NASA-TM-X-63130; X-641-68-75). CFSTI.

The complete first-order adiabatic correlation function of Dalgarno and Lynn were applied to the problem of low-energy elastic positron scattering by hydrogen and helium atoms. This approach is now extended to yield rigorous lower bounds on the scattering phase shifts in the case of hydrogen and "quasi bounds" for helium. In addition, the positron annihilation rate in helium is reevaluated, and lower values are now found, with the enhancement factor over the Dirac rate varying between 1.5 and 1.8. Some comparisons are made between the present method and other recent work. (auth)

38724 (N-68-19386) ELASTIC SCATTERING OF SLOW ELECTRONS BY TWO-ELECTRON IONS. McDowell, M. R. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 29p. (NASA-TM-X-63137; X-641-68-60). CFSTI.

A one-channel model, previously used for He, is extended to allow calculation of elastic scattering by H^- and Li^+ at energies up to three rydbergs. Nonseparable ground-state wave functions are used, allowance being made for exchange and dipole and quadrupole polarization potentials. Results for Li^+ are in good agreement with quantum-defect-method values. Calculated differential cross sections for elastic scattering by H^- at energies of one half and one Rydberg are presented. Deviations from Coulomb scattering are marked. (auth) (STAR)

38725 (N-68-22686) FORMATION OF IONIZED EXCITED STATES FROM THE LOSS OF THE METASTABLE ELECTRON IN THE NOBLE GAS ATOMS. Koozekanani, S. H. (Ohio State Univ., Columbus. Electroscience Lab.). Apr. 19, 1968. 12p. (NASA-CR-94388; TR-1093-39). CFSTI.

It is shown that when the metastable electron of a noble gas atom is removed by a fast collision it is quite possible for the atom to be ionized and excited at the same time. Excitation cross sections for these processes have been calculated in terms of the cross sections for removing the electrons. (auth) (STAR)

38726 (NP-17522) SURFACE AND VACUUM PHYSICS INDEX. Volume 3, No. 4(324-542). Hilsenbeck, D. (ed.). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 102p. Dep.

A listing is presented of 196 articles on various aspects of plasma physics. Subject and author indexes are included. (M.O.W.)

38727 (ORNL-TM-2251) A COMPARISON OF NON-RELATIVISTIC HARTREE-FOCK CALCULATIONS FOR SELECTED ATOMS AND IONS. Nestor, C. W. Jr. (Oak Ridge National Lab., Tenn.). June 13, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

This memorandum is a collection of the results of several recent Hartree−Fock calculations of electronic wave functions, one-electron energies, total energies and expectation values of powers of r, for the atoms fluorine, neon, chlorine and argon and for the neutral atom and several ions of bromine. Results from two analytic Hartree−Fock calculations and two numerical Hartree−Fock calculations were included in the tabulation, and good agreement between them for one-electron and total energies was found. As might be expected, the agreement is good for the expectation values of small powers of r and becomes worse for the larger powers of r. (auth)

38728 (SGAE-PH-65/1968) MOLECULAR DYNAMICS OF METHANE IN ARGON. Eder, O. J.; Egelstaff, P. A. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1968. 17p. Dep.

Inelastic and quasi-elastic scattering of 5.3-Å neutrons was studied for the system methane in argon at 86°K. Experimental data were taken for two concentrations (1.6 and 3.2 molar %), and six scattering angles. A discussion of the changes in the scattering pattern as compared to scattering experiments on pure methane performed under comparable conditions is presented. Using a new approach for the rotational motion of the methane molecules, a comparison with experimental data is made, assuming the methane molecule to rotate nearly freely at short times and undergo rotational diffusion at long times, while discussing the center-of-mass motion in terms of a modified "itinerant oscillator" model. The data are consistent with the view that the argon atoms form a "cage" around the methane molecules in which the rotation is continuously but weakly hindered and where the long-time translational motion can be described by simple diffusion, while for the short-time behavior some new approach is needed. (auth)

38729 (SLAC-Trans-82) IONIZATION ENERGY LOSSES OF RELATIVISTIC PARTICLES. Lorikyan, M. P. Translated by Robert Addis for Stanford Linear Accelerator Center, Calif., from Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 18: No. 6, 109-11(1965). 5p. Dep. CFSTI.

For relativistic particles passing from a vacuum into matter, the increase in ionization energy losses for different film thicknesses was used to determine the optimal thickness for which the polarization of the medium does not affect the ionization energy-losses in the thin boundary layer. Data for increase in electron energy losses from ionization in polystyrene are presented. (TSS)

38730 (UCRL-14190) A NEW MONTE CARLO METHOD FOR COMPUTING THE OUTCOME OF PHOTON REACTIONS WITH ATOMS. Brown, M. Z.; McIntosh, C. H.; Terrall, J. R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1965. Contract W-7405-eng-48. 41p. Dep. CFSTI.

A procedure is described for selecting a photon reaction with an atom and then calculating the energy and cosine of an emerging photon from probability distributions. The main feature of this procedure is that coherent scattering as well as incoherent scattering is taken into account in less computing time (on the 7094 at least) than that required by older methods which dealt only with Compton scattering. The inclusion of coherent scattering means that the angular distribution has an appreciable forward bias at all energies and especially at low energy. Compton scattering, on the other hand, predicts about equal forward and backward scattering at low energy. Coherency also raises the scattering cross section at low energies (KeV region) to where it competes with the photoelectric cross section to a much greater extent for medium and high-Z atoms. (auth)

38731 SENSITIVITY OF A STRIPPING ANALYZER FOR NEUTRAL HYDROGEN ATOMS IN THE ENERGY RANGE FROM 50 TO 300 eV. Fleischmann, H. H.; Tuckfield, R. G. Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Fusion, 8: 81-8(May 1968). (GA-8041).

The sensitivity of a neutral-hydrogen energy analyser consisting of a gas-stripping cell and an electric ion analyser was investigated in the energy range from 50 to 300 eV. A neutral atom flux

is produced by means of a plasma gun and multipole guide field. The density of this flux at the analyser entrance was determined using a calibrated secondary emission detector. The conversion efficiencies of various gases and their pressure dependence were examined. So far the use of oxygen as stripping gas seems to be the optimal choice. However, for all investigated stripping gases the sensitivity was found to be a steep function of the particle energy. This might limit the applicability of this analyser to energies above 100 eV, using the investigated gases for stripping. The overall energy resolution is estimated to be $\Delta E/E = 10$ to 15%. (auth)

38732 POSITRON LIFETIMES IN METAL HYDRIDES. Gainotti, A.; Ghezzi, C.; Manfredi, M.; Zecchina, L. (Univ., Parma, Italy). Nuovo Cim., 56B: 47-56(July 11, 1968).

Positron-decay curves in commercially available metal hydrides were measured, using a delayed coincidence system with 0.37 ns (FWHM) prompt time resolution. Evidence was found that the annihilation is complex, with two exponential decays of comparable intensities. In alkali-metal hydrides as in alkaline-earth hydrides, the annihilation rates Γ_1 and Γ_2 are found to increase with molecular densities. The experimental results are against the crude application of the simple decay model of the positron bound to a single H^- ion of the lattice. This model seems realistic only in the limit of very low molecular densities. Positron lifetimes in TiH_2 and ZrH_2 are found to be considerably shorter than lifetimes in divalent alkaline earth hydrides, probably owing to the presence of the highly polarizable electrons in the conduction band. (auth)

38733 PULSE SOURCE OF HIGH DENSITY ATOMIC HYDROGEN. Voronov, G. S.; Martakova, N. K. (Physical Inst., Moscow). Prib. Tekh. Eksp., No. 2, 23-5(Mar.-Apr. 1968). (In Russian).

A method for the production of H with evaporation of titanium, saturated with hydrogen, during heating with a Nd laser, was investigated. At radiation intensity of 3×10^7 W/cm^2 at a distance of 3 cm from the target, a hydrogen density of 10^{12} cm^{-3} was obtained with admixture of molecular hydrogen ~20%. The evaporated material contains also neutral atoms and titanium ions. The quantity of neutral Ti atoms was approximately the same as that of H. The degree of ionization of titanium plasma is ~10^{-6}. H^+ and H_2^+ ions were not observed. (tr-auth)

38734 SCREENING CONSTANTS FOR A RELATIVISTIC DESCRIPTION OF ATOMIC SYSTEMS. Denti, P. (Univ., Messina, Italy). Nuovo Cim., 56B: 105-10(July 11, 1968).

Relativistic one-electron wave functions for atomic systems are approximated by Dirac's screened hydrogenic wave functions. Our screening constants are calculated starting from the well-known Slater rules by means of a relativistic generalization. It is shown that one has no longer any general rule to apply, but it is necessary to carry out some simple calculation for each atomic system in order to obtain the screening constants. Calculations were performed for the elements from Be to Ne, from Mg to Ar and from Zn to Kr, but they could easily be extended to all the atomic systems. The results are briefly discussed. (auth)

38735 ROTATIONAL AND VIBRATIONAL EXCITATION OF MOLECULAR IONS BY ELECTRONS. Boikova, R. F.; Ob'edkov, V. D. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz., 54: 1439-44(May 1968). (In Russian).

The excitation of rotational vibrational states of diatomic molecular ions is considered in the Born–Coulomb approximation. A "direct" nonresonance excitation mechanism of the molecules is assumed. The transition cross section is represented in the form of a sum of partial moments of the radial matrix elements. The sum can be evaluated exactly for dipole molecules and yields an analytic expression for the excitation cross section. For quadrupole molecules the result has been obtained in elementary functions in the vicinity of the excitation threshold or higher. The vibrational excitation cross sections for H_2^+ and HeH^+ ions are calculated. Their maximum values are respectively 1.3×10^{-16} and 7.1×10^{-16} cm^2. (auth)

38736 THEORY OF RESONANCE BRAGG SCATTERING OF γ QUANTA ON REGULAR CRYSTALS. Kagan, Yu.; Afanas'ev, A. M.; Perstnev, I. P. Zh. Eksp. Teor. Fiz., 54: 1530-41(May 1968). (In Russian).

A detailed analysis is presented of the effect of suppression of inelastic scattering channels on the character of the angular and energy dependences of Bragg reflection of γ quanta from perfect single crystals in the presence of resonance nuclear and Rayleigh electron scattering mechanisms. It is shown that if the Bragg condition is satisfied exactly total reflection should be possible (and hence suppression of inelastic reaction channels), even if the case of a pure resonance interaction between the γ quanta and nuclei, irrespective of the relation between the cross sections for the elastic and inelastic processes. A general analytic expression is derived for the (angular) integral intensity of Bragg reflection for arbitrary relations between the imaginary and real parts of the dynamic equation coefficients. The influence of interference between nuclear and electron scattering on the curves for reflection from perfect crystals is analyzed in detail. A brief analysis of interference is presented for the case of mosaic crystals and the interference curves are compared for perfect and mosaic crystals. (auth)

38737 CHARGE STATE OF LITHIUM IONS IN GASES. Wendt, M.; Hartung, J. (Univ., Jena, Ger.). Z. Naturforsch., 23a: 247-51(Feb. 1968). (In German).

Beams of Li^+ ions with velocities between 4×10^8 cms^{-1} and $8 \cdot 10^8$ cms^{-1} were brought into charge equilibrium in the gases H_2 and air. The fractional amounts of Li^0, Li^+, Li^{2+} and Li^{3+} are measured. The neutral particles were detected in a simple way. Extrapolation of our results gives good agreement with data of Allison for ion velocities $v \leq 3.5 \times 10^8$ cms^{-1}. The equilibrium charge $\bar{q}$ in hydrogen was found to be smaller than that in air at velocities up to 6×10^8 cms^{-1} but larger at higher velocities. For the ratios of the equilibrated beam components with charge 3 and 2 ($F_{3\infty}/F_{2\infty}$) in H_2 and air relations are given which enable an extrapolation of the data for $\bar{q}$ to higher energies. (auth)

38738 IONIZATION OF GASES BY 0.2 TO 1.8-MeV He^+ IONS. Pivovar, L. I.; Levchenko, Yu. Z.; Grigor'ev, A. N. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 1310-17(May 1968). (In Russian).

The effective cross sections for formation of slow positive ions and free electrons in gases of H_2, N_2, He, Ne, Ar, and Kr by 0.2- to 1.8-MeV He^+ ions were measured. The data are compared with available data on ionization of the same gases by He^+ ions with energies up to 1.0 MeV. When possible the cross sections are compared with those calculated theoretically. The effective charge is estimated on the basis of the cross sections for pure ionization and by comparing them with the cross sections for proton ionization. (auth)

38739 EXPERIMENTAL INVESTIGATION OF THE ELASTIC QUASI-MOSAIC EFFECT. Sumbaev, O. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 54: 1352-60(May 1968). (In Russian).

The elastic quasi-mosaic effect arising on diffraction of x or gamma rays on elastically deformed anisotropic single crystals is investigated experimentally. This effect was previously investigated theoretically in connection with the explanation of the features of focusing crystal-diffraction spectrometers. Satisfactory agreement with the theory was found. It is pointed out that the effect may be employed in designing diffraction instruments. Thus, the resolving power, as shown in the present work, can be considerably increased (by 7 to 8 times). (auth)

38740 DIFFRACTION OF RESONANCE γ RAYS ON NUCLEI AND ELECTRONS IN TIN SINGLE CRYSTALS. Voitovetskii, V. K.; Korsunskii, I. L.; Novikov, A. I.; Pazhin, Yu. F. Zh. Eksp. Teor. Fiz., 54: 1361-73(May 1968). (In Russian).

Diffraction of resonance γ rays in ^{119}Sn single crystals is investigated experimentally. The nature of the scattering spectra at the Bragg angle as depending on the relation between the nuclear and electron scattering amplitudes is analyzed. Diffraction of resonance-scattered radiation on ^{119}Sn nuclei and interference of resonance-scattered radiation with the radiation scattered on electrons are distinctly observable. The experimental data agree with the calculations for crystals with a mosaic structure. (auth)

38741 ELASTIC SCATTERING OF ELECTRONS ON HELIUM ATOMS. Peterkop, R. K. (Inst. of Physics, Riga). Zh. Eksp. Teor. Fiz., 54: 1581-9(May 1968). (In Russian).

An equation set is derived and the phase shift of the s wave for elastic scattering of electrons on helium atoms is calculated by taking into account exchange and correlations. The method applied yields the lower boundary of the phase shift if the exact wave function of the atom is employed. Thirty two (and in one case 36) correlation terms are taken into account in the calculations. It is found that the results should considerably change if terms are retained which vanish when the exact atomic wave function is applied. When such terms are not taken into account the scattering phase shift is in good agreement with the most exact results of other methods. A less accurate value was obtained for the scattering length. The behavior of the phase shift as a function of number of correlation terms for $k = 1.25$ (k is the momentum of the incident electron in atomic units) indicates that resonance should appear for $k < 1.25$. For $k \leq 1$ no signs of resonance have been observed. (auth)

38742 "BOLOMETRIC" TECHNIQUE FOR THE rf SPECTROSCOPY OF STORED IONS. Dehmelt, H. G.; Walls, F. L. (Univ. of Washington, Seattle). Phys. Rev. Lett., 21: 127-31 (July 15, 1968).

A simple technique is proposed in which rf transitions between suitable energy levels of an atomic or molecular ion, a member of a stored, radiatively thermalized ion gas, may be detected by monitoring the translational temperature of the ion gas. An experimental study of the cyclotron resonance of an electron gas confined in a Penning trap demonstrates its usefulness, and possible applicability to spin resonance. (auth)

38743 MEASUREMENT OF THE SOMMERFELD FINE-STRUCTURE CONSTANT BY LEVEL CROSSING IN ATOMIC HYDROGEN. Metcalf, Harold; Brandenberger, J. R.; Baird, J. C. (Brown Univ., Providence). Phys. Rev. Lett., 21: 165-9(July 15, 1968).

The Sommerfeld fine-structure constant was measured in atomic hydrogen by level-crossing spectroscopy at 3484 G. The fine-structure interval is found to be 10,969.15(12) MHz and the fine-structure constant $\alpha^{-1} = 137.0353(8)$. (auth)

38744 Q STRUCTURE AND INNER-SHELL VACANCIES IN NEON–NEON AND KRYPTON–KRYPTON COLLISIONS. McCaughey, Michael P.; Knystautas, Emile J.; Hayden, Howard C.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev. Lett., 21: 65-6(July 8, 1968).

In close encounters of the systems Ne–Ne, Ne^+–Ne, and Ne^{2+}–Ne, electrons of 750-eV energy are produced. The numbers of such fast electrons are found to depend upon the charge state of the incident particle (0, +1, or +2) in the ratio of 0.6, 1.0, and 2.0, respectively. This agrees in part with a prediction by Lichten. In Kr^+–Kr collisions, there is a sudden change in the average number of electrons lost for 9° scattering at 25-keV incident energy. (auth)

38745 METHOD AND APPARATUS FOR REMOVING IMPURITY GAS FROM A PARTICLE BEAM. Post, Richard F. (to United States Atomic Energy Commission). U. S. Patent 3,387,174. June 4, 1968.

This patent relates to apparatus for deflecting slow thermal energy particles from an energetic neutral particle beam. Electromagnetic energy strongly absorbed by slow particles moving with a beam is directed across the beam to impart a transverse energy component to the slow particles, deflecting them from the beam, thereby yielding a purified energetic neutral particle beam for use, e.g., in controlled fusion research. (AEC)

38746 INVESTIGATION OF THE ADSORPTION OF POTASSIUM IONS ON THE SURFACE OF MOLYBDENUM. Ban'kovskii, N. G.; Stefanovskaya, E. M.; Fedorinov, V. P. (Kalinin Polytechnical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 113-17(July 1968).

Translated from Fiz. Tverd. Tela, 10: 153-8(Jan. 1968).

The average adsorption residence time of ions was determined from the surface ionization current flowing from a sample subjected to modulated beams of potassium atoms of various intensities. The investigation was carried out in the temperature range 960 to 1200°K. It was found that, in this temperature range, the heat of desorption depended strongly on temperature and this dependence was linear. On the assumption that the adsorption time constant was of the order of 10^{-13} sec, the heat of desorption was determined as a function of temperature in the investigated temperature range. (auth)

38747 TIME-DEPENDENT HYPERFINE INTERACTION OF ^{169}Tm IN IRON. Deutch, B. I. (Univ. of Aarhus, Denmark); Nielsen, K. Bonde; Bernas, H. Phys. Lett., 27B: 209-11(July 8, 1968).

The temperature dependence of the perturbed angular correlation of the 198- to 110-keV γ cascade in ^{169}Tm implanted in iron foil is consistent with a time-dependent magnetic interaction with a relaxation time constant $\tau_S = 2$ ps. (auth)

38748 MEASUREMENT OF THE ANGULAR CORRELATION OF SUCCESSIVELY EMITTED X-RAYS AND OF THE PARTIAL FLUORESCENCE YIELD ω_{KL} OF LANTHANUM. Beste, Heinz Wilhelm (Univ., Goettingen, Ger.). Phys., 213: 333-40(1968). (In German).

An experimental check of the angular correlation between the L and K x rays emitted following K ionization was undertaken. An anisotropy $D = (8 \pm 6)\%$ was found. This result is consistent with the predictions of the theory of unperturbed angular correlations within the large but hardly reducible error. Also explored was a new method of measuring the partial fluorescence yield ω_{KL} resulting in a value of $\omega_{KL}(180°) = (12.3 \pm 2.2)\%$. The influence of the above-mentioned anisotropy D on ω_{KL} is discussed. (auth)

38749 EXCITATION OF N_2^+ IONS BY ELECTRONS AT NEAR THRESHOLD ENERGIES. Lee, A. R.; Carleton, N. P. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.). Phys. Lett., 27A: 195-8(July 1, 1968).

The absolute cross sections were measured for the excitation of the 0–0 band of the first negative system of $N_2^+[(X^2\Sigma_g^+) \rightarrow (B^2\Sigma_u^+, v = 0) \rightarrow (X^2\Sigma_g^+, v = 0)]$ by electron impact upon N_2^+ ions in the energy range 5 to 30 eV. The crossed-beam technique was used. (auth)

38750 ISOTOPE SHIFT OF (4f–5d) ELECTRON TRANSITIONS IN Eu^{3+}. Eu^{2+} SPECTRUM AND NUCLEAR RADIUS VARIATIONS. Koniordos, I.; Winkler, R. (Univ. Berlin). Phys. Lett., 27A: 198-202(July 1, 1968). (In German).

Isotopic shifts of +(160 ± 15) and +(168 ± 5) mK were determined for $(4f^7)-(4f^6 5d)$ and $(4f^7)6s-(4f^6 5d)6s$ transitions in free Eu^{2+} and Eu^{3+} ions, respectively. With Moessbauer isomeric shift data they now yield more accurate differences in charge radii for excited ^{151,153}Eu nuclei. (auth)

38751 MATRIX ELEMENTS BETWEEN CONFIGURATIONS HAVING SEVERAL OPEN SHELLS. I. Armstrong, Lloyd Jr. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 172: 12-17(Aug. 5, 1968).

The formalism of second quantization is used to calculate matrix elements of the Coulomb operator between configurations having several open shells. Antisymmetric many-particle states are formed by products of creation operators acting on the vacuum state, and the Coulomb interaction is written as a product of creation and destruction operators. Manipulation of all of these operators leads to results equivalent to those obtained by Fano. (auth)

38752 MATRIX ELEMENTS BETWEEN CONFIGURATIONS HAVING SEVERAL OPEN SHELLS. II. Armstrong, Lloyd Jr. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 172: 18-25(Aug. 5, 1968).

The second-quantization formalism is used to investigate coefficients of fractional parentage for mixed configurations. These coefficients are shown to be proportional to reduced matrix elements of coupled creation operators; this proportionality makes their calculation straightforward. A prescription is given for use of these coefficients which simplifies the calculation of matrix elements involving configurations with several open shells. (auth)

38753 MEASUREMENTS OF THE STARK BROADENING OF TWO NEUTRAL HELIUM LINES IN A PLASMA. Greig, J. R.; Lim, C. P.; Moo-Young, G. A.; Palumbo, G.; Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev., 172: 148-53 (Aug. 5, 1968).

A detailed study was made of the broadening of the lines λ3889 Å (width only) and λ5016 Å (shift and width) of neutral helium in the plasma produced in an electromagnetically driven T tube operating in helium–hydrogen gas mixtures. The electron density in the plasma was found from the broadening of H_δ, while the temperature was determined from the ratio of the intensity of H_δ to that of the underlying continuum. Temperatures were in the range 20,000 to 30,000°K; electron densities varied from 10^{16} to 6×10^{17} cm^{-3}. The broadening of the line λ3889 Å was found to increase linearly with electron density; and it compared well with calculations based on the generalized impact theory, except for (constant) correction factors ranging from about 0.9 to 1.0 (depending on which of the various calculations is referred to). For the line λ5016 Å, neither of the previous calculations, nor a correction discussed here, predicts either the width or the shift variations satisfactorily; all the calculations give significantly wider lines above the electron densities of 10^{17} cm^{-3} than are found experimentally. Also, as the electron density increases, the calculated shifts all become increasingly larger than those found experimentally. However, at the low densities most deviations are small (≲20%). (auth)

38754 ESTIMATION OF THE CROSS SECTIONS FOR COLLISION TRANSFER OF EXCITATION IN HELIUM. Chan, F. T. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 172: 96-8 (Aug. 5, 1968).

The Stueckelberg formula is used to estimate the cross sections for the collision transfer of excitation of helium atoms: $He(1^1S_0) + He(4^3P) \rightarrow He(1^1S_0) + He(4^3S) \pm \Delta E$ and $He(1^1S_0) + He(4^3P) \rightarrow He(1^1S_0) + He(4^3D) \pm \Delta E'$. At T = 600°K, the calculated cross sections are $Q_{4P-4S}tr = 0.93 \times 10^{-15}$ cm^2 and $Q_{4P-4D}tr = 2.25 \times 10^{-15}$ cm^2, as compared to the experimental values $(0.35 + 0.03) \times 10^{-15}$ cm^2 and $(0.99 + 0.24) \times 10^{-15}$ cm^2, respectively. (auth)

38755 VIBRATIONAL EXCITATION EFFECTS ON CHARGE-TRANSFER PROCESSES INVOLVING H_2^+ AND D_2^+ BETWEEN 70 AND 1000 eV. Hayden, Howard C.; Amme, Robert C. (Univ. of Denver). Phys. Rev., 172: 104-9(Aug. 5, 1968).

Charge-transfer cross sections were measured for H_2^+ in H_2, D_2, and Ar, and for D_2^+ in H_2 as a function of both incident ion energy and ion-source electron energy. The ion energy range was 70 to 1000 eV for the $H_2^+ + H_2$ case and 250 to 1000 eV for the processes $H_2^+ + D_2$, $H_2^+ + Ar$, and $D_2^+ + H_2$. Ionizing electron energy was varied from 16 to 21 eV. The primary H_2^+ ions were magnetically separated from other beam constituents. Charge-transfer cross sections were deduced from slow-ion currents measured in a charge-transfer cell employing a cylindrical slow-ion energy analyzer. Measured cross sections for H_2^+ in H_2 decreased 5 to 10% as the electron energy was increased over the 5 eV interval. The minimum in the $H_2^+ + H_2$ cross-section–versus–energy curve observed by other investigators was found to persist at low electron energies, thus ruling out the possibility of contributing exothermic effects by highly excited incident ions. The lack of agreement between experimental results and theory is discussed. Sizable differences were observed at low electron energies between $D_2^+ + H_2$ and the $H_2^+ + D_2$ cross sections. Both results fell below those for the symmetric $H_2^+ + H_2$ case. At higher electron energies, these differences were smaller. An overall change of 20% in the $H_2^+ + Ar$ cross section was observed over the given electron-energy interval with 700-eV ions. (auth)

38756 RESONANCE SCATTERING AND THE DRIFT MOTION OF ELECTRONS THROUGH GASES. Frommhold, Lothar (Univ. of Texas, Austin). Phys. Rev., 172: 118-25(Aug. 5, 1968).

Density-dependent values of the electron drift velocity in hydrogen, deuterium, and nitrogen gas have recently been reported. Their reciprocal values are a linear function of the gas density. Several possible theoretical explanations are discussed, some of which lead to such a linear pressure dependence. It is concluded that electron trapping by some low-energy resonance states is likely to take place. "Rotational resonances" in atom–rotator scattering are described in a theoretical paper by Kouri, and it is thought that rotational resonances should be observed in electron–molecule scattering as well, at electron energies close to thermal energy. At the higher electron energies (≃1 eV), the known "single-particle" resonance states of H_2 and N_2 near 2 eV are probably responsible for the delay in the electron motion at high densities. (auth)

38757 POLARIZATION IN LOW-ENERGY ELECTRON SCATTERING: CARBON AND NITROGEN. Henry, Ronald J. W. (Kitt Peak National Observatory, Tucson, Ariz.). Phys. Rev., 172: 99-103(Aug. 5, 1968).

The polarized-orbital method has been applied to low-energy scattering of electrons from atomic carbon and nitrogen. Cross sections for the elastic scattering of electrons by C and N are given for energies up to 5.5 and 10 eV, respectively. The shape of the cross sections for nitrogen is in good agreement with the shape obtained by experiment. The photodetachment cross sections for C^- and N^- are given for ejected electron energies <7 eV, and those for C^- are found to be in good agreement with experiment when polarization terms are included and the dipole velocity approximation is used. For N^-, photodetachment cross sections are given for electron affinity values of 0.05 and 0.15 eV. (auth)

38758 RUBIDIUM AND CESIUM EXCITATION TRANSFER IN NEARLY ADIABATIC COLLISIONS WITH INERT GASES. Gallagher, Alan (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 172: 88-96(Aug. 5, 1968).

The cross sections for rubidium $5^2P_{\frac{1}{2}} \rightleftharpoons 5^2P_{\frac{3}{2}}$ and cesium $6^2P_{\frac{1}{2}} \rightleftharpoons 6^2P_{\frac{3}{2}}$ excitation transfer due to inert-gas collisions were measured. The temperature of the collision vessel has been varied from 300°K to 900°K in order to partially establish the velocity dependence of these cross sections (the alkali resonance-line depths were always much less than 1). The various cross sections exhibit a systematic behavior that are combined to find the general shape of a "universal" cross section that ranges across six orders of magnitude, starting just below the threshold for "sudden" collisions. The surprisingly large influence of optical line broadening on these excitation-transfer measurements was removed as a source of error. (auth)

38759 PHOTODISSOCIATION OF H_2^+ AND D_2^+: THEORY. Dunn, Gordon H. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 172: 1-7(Aug. 5, 1968).

Theory is described and calculations made for photodissociation cross sections of H_2^+ and D_2^+ from each of the ion's 19 (27) vibrational levels. Cross sections are summed over an assumed Franck–Condon distribution of initial vibrational states to give a predicted cross section for comparison with experiment. Auxiliary calculations are made of some of the cross sections using the common δ-function approximation to the continuum radial wave functions, and a comparison made with the results using more exact wave functions shows very good agreement for photodissociation from the lowest vibrational levels, but very poor agreement for photodissociation from higher levels. (auth)

38760 FULLY COUPLED HARTREE–FOCK CALCULATIONS OF THE REFRACTIVE INDEX, DYNAMIC POLARIZABILITY, AND VERDET COEFFICIENTS OF HELIUM, BERYLLIUM, AND NEON. Kaveeshwar, V. G. (State Univ. of New York, Buffalo); Chung, Kwong T.; Hurst, R. P. Phys. Rev., 172: 35-44(Aug. 5, 1968).

Fully coupled Hartree–Fock calculations of the refractive index, dynamic polarizability, and Verdet coefficients of He, Be, Ne, and the corresponding 2-, 4-, and 10-electron isoelectronic series are presented. The time-dependent Hartree–Fock perturbation equations are derived and solved using a variational method, in which the zero-order and the perturbed wave functions are represented by analytical functions containing adjustable parameters which are optimized according to the variational technique. The numerical results for both the refractive index and the Verdet coefficients are fitted to polynomials in even powers of $1/\lambda$, where λ is the wavelength. In this work it is found that the computed refractive indices differ from the corresponding experimental values due to Cuthbertson and Cuthbertson by a very nearly constant amount. That is, if the computed dynamic polarizabilities are adjusted so as to equal the experimental polarizability α at zero frequency, then the experimental and theoretical curves of refractive index versus frequency are nearly identical. This adjustment in α is around 5% (for He) and 10% (for Ne) of the experimental static polarizabilities. Finally, the calculated transition frequencies are around 2% too large for He, 17% too large for Ne, and 9% too small for Be. (auth)

38761 CORRELATION COEFFICIENTS FOR ELECTRONIC WAVE FUNCTIONS. Kutzelnigg, Werner (Univ., Goettingen, Ger.); Del Re, Giuseppe; Berthier, Gaston. Phys. Rev., 172: 49-59(Aug. 5, 1968).

Electron correlation in atoms and molecules can be analyzed in terms of correlation coefficients similar to those used in probability theory and mathematical statistics. Different correlation coefficients can be defined for angular, radial, and momentum correlation in atoms and for axial (left-right), equatorial, and radial (in-out) correlation in molecules. The correlation coefficients are closely related to certain coefficients of the so-called natural expansion of the wave function. Nonvanishing correlation coefficients are obtained for the Fermi correlation in the independent-particle model as well as for electron correlation proper. Numerical examples show that the correlation coefficients for atoms are of the order of −0.05, suggesting that the correlation is usually small and negative, as compared with ±1 for "perfect" correlation. However, positive correlation coefficients may occur, in particular for excited states. Correlation in supersystems consisting of two nonoverlapping systems at large distances, and the distinction between interorbital and intraorbital correlation, are also discussed. (auth)

38762 CONCERNING THE STABILITY OF THE NEGATIVE IONS H^- AND Li^-. Goddard III, William A. (California Inst. of Tech., Pasadena). Phys. Rev., 172: 7-12(Aug. 5, 1968).

The unrestricted Hartree–Fock (UHF) wave functions for H^- and for Li^- have the Z + 1th electron at infinity, and thus have the same energy as the neutral atoms. That is, the stability of these negative ions is not accounted for by Slater determinant wave functions, not even if the orbitals are allowed to split. It is shown that the difficulty here is that the uhf wave functions do not have the proper spin symmetry. If the Slater determinant is spin-projected and the orbitals optimized after projection (to obtain what is called the GF wave function), these negative ions are predicted correctly to be stable. Since the GF wave function leads to an independent particle interpretation, it is seen that instantaneous polarization of the neutral-atom orbitals by the Z + 1th electron is not crucial to the stability of these negative ions. From an analysis of the differences between the UHF and GF wave functions, it is found that the key term leading to stability of the negative ions is an exchange term (particularly the nuclear attraction part of this term), just like the exchange term important in the valence-bond wave function of H_2. (auth)

38763 EFFECT OF ANISOTROPY ON EMISSIVITY. Autio, Gordon Wilbert. Ithaca, N. Y., Cornell Univ., 1968. 136p.

Thesis.

The effect of anisotropy on normal spectral emissivity has been investigated both experimentally and theoretically for a variety of anisotropic materials. The results were obtained at temperatures near 800°C over a wavelength range from visible to near infrared (0.60 to 11 microns) in both hydrogen and argon atmosphere. The probing technique was employed to measure normal spectral emissivity. Single-crystal beryllium in its free-carrier intraband absorption region ($\lambda \gtrsim 2.50$ microns) exhibits a normal

spectral emissivity of the A face, $(10\bar{1}0)$, greater than that of the C face, (0001). Thus, absorption is greater in the basal plane ($\vec{E} \perp$ c-axis) than in the prismatic plane ($\vec{E} \parallel$ c-axis) corresponding to an inverse relationship of normal spectral emissivity to absorption in the intraband region. The effect of impurity in beryllium on normal spectral emissivity is quite pronounced in that impure polycrystalline beryllium exhibits significantly higher values than pure single crystals over all wavelengths (0.60 to 7 microns). Single-crystal zirconium in its interband absorption region ($\lambda \gtrsim$ 9 microns) exhibits a normal spectral emissivity of the C face greater than that of the A face. Thus, absorption is greater in the basal plane ($\vec{E} \perp$ c-axis) than in the prismatic plane ($\vec{E} \parallel$ c-axis), at most wavelengths in the range (0.60 to 7 microns), corresponding to a direct proportionality of normal spectral emissivity to absorption in the interband region. Pyrolytic boron nitride in its lattice absorption region ($\lambda \gtrsim$ 2.60 microns) exhibits a normal spectral emissivity of the A face greater than that of the C face. This corresponds to the greater absorption in the basal plane than in the prismatic plane. The Reststrahlen of C-face pyrolytic boron nitride occurs at about 7.31 microns ($\vec{E} \perp$ c-axis) and the A-face 2-phonon peak (superposition of the in-plane Reststrahlen and the out-of-plane 2-phonon peak) occurs at about 7 microns. Hot-pressed polycrystalline boron nitride exhibits a normal spectral emissivity dispersion closer to A-face pyrolytic boron nitride. The polycrystalline BN exhibits an absorption peak near 7 microns, which is a balance between the out-of-plane 2-phonon peak and the in-plane Reststrahlen. Pyrolytic graphite at $\lambda \gtrsim 1$ micron exhibits the greatest anisotropy in normal spectral emissivity between the two major orientations. The C face exhibits the lower normal spectral emissivity corresponding to the greater absorption in the basal plane. Pyrolytic graphite C faces deposited at higher temperatures exhibit generally lower normal spectral emissivity (0.60 to 11 microns) corresponding to an increase in basal-plane absorption as the deposition temperature increases. A further increase in basal-plane absorption upon extreme annealing results in the lowest normal spectral emissivity of C-face pyrolytic graphite. This highly annealed C-face pyrolytic graphite exhibits a normal spectral emissivity dispersion close to the theoretically predicted curve of C-face single crystal graphite. (TSS) (Disser. Abstr.)

38764 SELF-CONSISTENT-FIELD CALCULATIONS FOR THE TRANSLAWRENCIUM ELEMENTS: BEGINNING OF A 5g TRANSITION SERIES. **Larson, Allen C.; Waber, James T. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 48: 5021-5 (June 1, 1968).**

The preferred electronic configurations of the very heavy synthetic elements in the vicinity of atomic number 126 have been deduced through nonrelativistic self-consistent Hartree calculations made for many configurations. The resulting wave functions were used to compute the total average Hartree–Fock energy of each configuration. The configuration $8s^2 6f^1 5g^\nu$ emerges as more stable than either $8s^2 7d^1 5g^\nu$ or $8s^2 5g^{\nu+1}$. The principal chemical valences are 3+ and 2+; oxidation to 4+ would probably be difficult. (auth)

38765 COMPUTATIONAL PROCEDURE FOR THE CLOSE-COUPLED ROTATIONAL EXCITATION PROBLEM: SCATTERING OF DIATOMIC MOLECULES BY ATOMS. **Lester, William A. Jr.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 48: 4896-4904 (June 1, 1968).**

A computational procedure is described for the integration of the coupled differential equations and determination of the probability matrices required for the accurate evaluation of cross sections for rotational excitation of diatomic molecules. The Arthurs–Dalgarno theory of scattering of an atom by a rigid rotator is employed. The approach developed takes advantage of several of the computational schemes used in the field of electron–atom scattering, particularly those of Smith. The principal virtue of the present computational method is its capability of generating "exact" results to serve as standards against which to compare various approximations such as sudden, dominant-coupling, and distorted-wave. (auth)

38766 SEMICLASSICAL THEORY OF INELASTIC SCATTERING: AN INFINITE-ORDER DISTORTED-WAVE APPROXIMATION. **Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys., 48: 4838-42 (June 1, 1968).**

A previously derived semiclassical theory of inelastic scattering is generalized to include collisions where the trajectory is nonlinear. Schroedinger's equation is expressed as an infinite-order perturbation series using the radial wave functions corresponding to the spherically symmetric part of the potential as the unperturbed solution. In the classical limit this series simplifies, and the scattering matrix is obtained by exponentiating a phase shift matrix obtained as a simple integral over the classical trajectory corresponding to the spherically symmetric part of the potential. A second-order term is obtained to correct for the deviation from this trajectory. (auth)

38767 SPIN POLARIZATION OF SLOW ELECTRONS ELASTICALLY SCATTERED BY NOBLE GAS ATOMIC BEAMS. **Schackert, Klaus (Johannes Gutenberg Univ., Mainz). Z. Phys., 213: 316-22 (1968). (In German).**

The angular dependence of spin polarization $P(\theta)$ of electrons elastically scattered by noble gas atomic beams is measured in a double-scattering experiment for electron energies between 40 and 150 eV and over an angular range from 30 to 150°. Maximum degree of polarization measured is $P = +39.5\% \pm 2.6\%$ (Xe; 150 eV; $\theta = 60°$). The results are compared with the theoretical values of Coulthard, which agree approximately with the measurements only for xenon. For all lower atomic numbers the experimental values are higher than the theoretical ones. (auth)

38768 ALIGNED EXCITATION OF METASTABLE 6s 5d LEVELS IN Ba I SPECTRUM AND MEASUREMENT OF THE G_J VALUES. **von Oppen, Gebhard (Technische Univ., Berlin). Z. Phys., 213: 261-72 (1968). (In German).**

In an atomic beam experiment Ba atoms were excited in the metastable levels of the 6s5d configuration by optical pumping and electron impact. The three states $6s5d\,^1D_2$ and $^3D_{1,2}$ were populated by optical excitation of the $6s6p\,^1P_1$ and $^3P_1$ levels respectively, which decay partly into the metastable states. The $^1D_2$ and $^3D_3$ level could be excited and aligned by impact of 50-eV electrons. Radiofrequency transitions between Zeeman sublevels were detected by resonance scattering of light, and the g_J values of the four 6s5d levels were measured: $g_J(^1D_2) = 1.0032(2)$, $g_J(^3D_1) = 0.4986(2)$, $g_J(^3D_2) = 1.1638(2)$ and $g_J(^3D_3) = 1.3341(2)$. (auth)

38769 LEVEL-CROSSING-EXPERIMENT TO INVESTIGATE THE HYPERFINE STRUCTURE OF THE $6s6p\,^3P_1$ LEVEL OF Ba I SPECTRUM. **von Oppen, Gebhard (Technische Univ., Berlin). Z. Phys., 213: 254-60 (1968). (In German).**

The hfs splitting of the stable odd Ba isotopes ^{135}Ba and ^{137}Ba ($I = 3/2$) in the $6s6p\,^3P_1$ state was investigated by level-crossing techniques. For both isotopes two crossings between Zeeman sublevels with $\Delta m_F = 2$ were detected by resonance scattering of the 7911 Å intercombination line using a Ba atomic beam. From the experimental results ratios of zero field hfs constants and the g_J value of the $^3P_1$ state were calculated, including second-order corrections. The results may be compared with double-resonance measurements in zero magnetic field. (auth)

38770 ION BOMBARDMENT OF SOLIDS. **Carter, G.; Colligon, J. S. London, Heinemann, 1968. 452p. 252s.**

The subject is reviewed under the following main headings: Introduction; collisions between atoms; secondary electron emission; secondary ion emission; penetration of ions; radiation damage; sputtering; ion trapping and gas release processes; ion bombardment techniques and application. (UK)

38771 ENERGY-LOSS SPECTRA OF SILVER FOILS COVERED WITH THIN CARBON LAYERS. **Daniels, J. (Univ., Hamburg). Z. Phys., 213: 227-32 (1968). (In German).**

The energy loss spectra of fast monochromatic electrons which have traversed Ag films covered with thin carbon layers show a distinct shift of the surface loss to lower energy and a decrease of its intensity with growing thickness of the carbon films. Both effects were found to be in good quantitative agreement with theoretical results calculated by means of the dielectric theory. (auth)

38772 LEVEL-CROSSING SIGNAL LINE SHAPES AND ORDERING OF ENERGY LEVELS. **Stroke, H. H.; Fulop, G.; Klepner, S. (New York Univ., N. Y.). Phys. Rev. Lett., 21: 61-4 (July 8, 1968).**

Theory and experiments are presented to show that, when correctly interpreted, the sign of the dispersion-shaped term which describes a part of the change in resonance scattering at level crossings can be used to determine the energy ordering of the crossing levels, and hence, in some cases, to obtain the sign of the nuclear magnetic moment. Because of a discrepancy in the literature in the theoretical prediction for the sign of the dispersion-shaped term, we have made a recalculation. The result is borne out by our experiments. (auth)

38773 SPONTANEOUS EMISSION PROBABILITIES AND QUANTUM EFFICIENCIES FOR EXCITED STATES OF Pr^{3+} IN LaF_3. **Weber, M. J. (Raytheon Research Div., Waltham, Mass.). J. Chem. Phys., 48: 4774- (May 15, 1968).**

Spontaneous emission probabilities for electric- and magnetic-dipole transitions from several electronic states of Pr^{3+} in LaF_3 are calculated using the Judd–Ofelt theory and experimental intensity parameters. The calculated radiative decay probabilities

are combined with observed fluorescence lifetimes to determine the quantum efficiencies of the $^1D_2$ and $^3P_0$ states. Although the lifetimes were measured at low temperatures and small Pr concentrations where competing nonradiative decay by multiphonon emission and ion-pair relaxation should be negligible, the predicted quantum efficiencies are less than unity. The radiative lifetimes obtained via the Einstein relations and measured integrated absorption and relative fluorescence intensities agree, however, with the observed lifetimes. The discrepancies appear to arise from approximations and possible limitations inherent in the approach used to calculate the radiative transition probabilities. Matrix elements of $U^{(\lambda)}$ for states of $4f^2$ in intermediate coupling are included in an appendix. (auth)

38774 QUANTUM-MECHANICAL CALCULATIONS OF THE INELASTIC CROSS SECTIONS FOR ROTATIONAL EXCITATION OF PARA AND ORTHO H_2 UPON COLLISION WITH He. Johnson, B. Robert; Secrest, Don (Univ. of Illinois, Urbana). J. Chem. Phys., 48: 4682-93(May 15, 1968).

The equations for computing the scattering T-matrix in the total-angular-momentum representation are derived, using the method of amplitude densities. It is shown that in the appropriate limit this method reduces to a first-order differential equation for the T matrix. In an Appendix a similar discussion is presented for the reaction matrix. Using the T-matrix approach, numerical solutions are obtained to the helium-atom–hydrogen-molecule scattering problem in both the close-coupling and distorted-wave approximations. Cross sections were computed for the J = 0 to J = 2 transitions in parahydrogen and the J = 1 to J = 3 transition in orthohydrogen. These results were calculated using both an interaction potential computed by Roberts and a potential computed by Krauss and Mies. The close-coupling and distorted-wave results are compared, and it is found that, in general, the distorted-wave cross sections are about 20% too high when Roberts potential is used and are about 10% too high when the less anisotropic Krauss and Mies potential is used. (auth)

38775 VIRIAL THEOREM, THE VARIATIONAL PRINCIPLE, AND NONLINEAR PARAMETERS IN QUANTUM MECHANICS: APPLICATION TO THE 3^1D AND 3^3D STATES OF THE HELIUM ISOELECTRONIC SERIES. Brown, Robert T. (Rice Univ., Houston, Tex.). J. Chem. Phys., 48: 4698-4703(May 15, 1968).

The connection between the virial theorem and the variational principle with respect to nonlinear parameters was investigated for a system of n particles interacting through Coulomb forces. It is found that if the nonlinear parameters are chosen to be n scale parameters and considered as the components of a position vector in an n-dimensional Euclidean space, the locus of points for which the virial theorem is satisfied is a path of steepest descent on the energy surface. It is thus possible to minimize the energy along a path of steepest descent without the necessity of calculating derivatives. As an example, variational wave functions and energies are obtained for the 3^1D and 3^3D states of the helium isoelectronic series through Z = 30, with the trial function a 39-term configuration-interaction expansion in members of a denumerably complete basis set. The calculated energies for He and Li^+ agree with observed values to within 0.000007 au. The agreement with energies obtained from Hylleraas-type expansions for $Z \leq 10$ is of the same order, and in some cases it is the configuration–interaction energy which is lower. (auth)

38776 CARRIER GENERATION AND TRANSPORT IN ANTHRACENE UNDER ELECTRON BOMBARDMENT. Delany, J. L.; Hirsch, J. (London Univ.). J. Chem. Phys., 48: 4717-24(May 15, 1968).

Bombardment of anthracene crystals by 10- to 60-keV electrons produces equal numbers of electrons and holes by an intrinsic process throughout the region penetrated by the beam. Over the range examined, the yield is proportional to the total energy deposited at the rate of 400 eV per carrier pair. In "good" crystals, the yield at room temperature is independent of the applied field (for fields >3 kV cm^{-1}). This is interpreted as saturation of the generation process. The results are compared with those reported for other forms of excitation. The values for the drift mobilities, viz., $\mu_e = 0.38$ and $\mu_h = 0.92$ cm^2 $sec^{-1} \cdot V^{-1}$, and their temperature coefficients, agree well with other published values. (auth)

38777 LYMAN SERIES OF IONIZED HELIUM IN THE EXTREME ULTRAVIOLET SOLAR SPECTRUM. Smith, Thomas Scott. College Park, Md., Univ. of Maryland, 1967. 68p.

Thesis.

This thesis is an analysis of data on solar emission in the Lyman lines of ionized helium (He(II)) obtained with the first Orbiting Solar Observatory (OSO-I) of the National Aeronautics and Space Administration and with a rocket spectroheliograph of the Naval Research Laboratory (NRL). The OSO-I yielded photoelectric scans of the region of the He(II) Lyman series from March 7, 1962 to May 15, 1962. Reliable counting rates were obtained for solar emission in the Lyman-alpha, gamma, and delta lines, during this period. All the lines vary with solar activity. Higher intensities are correlated with higher solar activity as measured by the calcium plage areas. A reliable estimate of continuum emission beyond the series limit and emission in other Lyman lines was not possible. The NRL spectroheliograph yielded images of the Sun in the He(II) Lyman-alpha line at 304 Å. A method of internal calibration gave relative brightnesses of the various features observed in the spectroheliograms. The correlation of the OSO-I line intensities with Ca K plages was used to derive contrasts-intensity ratios between plage and non-plage areas. The NRL data gave the contrast in 304 directly. Line ratios are derived in plage and non-plage regions from the contrasts and absolute calibration of the OSO-I spectrophotometer. In plages, the gamma and delta lines show noticeably greater emission relative to the alpha line. Various explanations for this anomalous enhancement are examined and it is concluded that the most reasonable explanation is that a plage is hotter and denser than a non-plage region. The He(II) emission in the chromospheric network is analyzed and interpreted to show that the spicule/corona interface is a region of steeper temperature gradient and higher density than in non-spicule/corona interface. (Disser. Abstr.)

38778 PRODUCTION OF POLARIZED BREMSSTRAHLUNG. Leikin, E. M.; Moroz, E. M.; Petukhov, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 229-30(Apr. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 293-4(Apr. 20, 1968).

It is suggested that the properties of radiation friction may be used to obtain polarized bremsstrahlung radiation of optimal intensity in cyclic accelerators. (J.H.R.)

38779 A MEASUREMENT OF THE FINE STRUCTURE CONSTANT BY LEVEL CROSSING IN ATOMIC HYDROGEN. Metcalf, Harold; Brandenberger, John; Baird, James C. pp 821-9 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

Previous determinations of the Sommerfeld fine structure constant α are reviewed. An experiment is briefly described for measuring α by observing a level crossing of atomic hydrogen in a magnetic field. The crossing of the level d with the level e is detected by observing part of the change in the spatial distribution of the reasonably scattered Lyman-α radiation. The available data are not yet sufficient for an accurate determination of α. (A.G.W.)

38780 WAVES OF IONIZATION IN A NITROGEN DISCHARGE. Garscadden, A.; Bletzinger, P. (Wright-Patterson Air Force Base, Ohio). Phys. Lett., 27A: 203-4(July 1, 1968).

Artificially excited waves of ionization in a low-pressure nitrogen discharge are identified as anode-directed forward waves. (auth)

38781 EXCHANGE POTENTIAL FOR ELECTRONS IN ATOMS AND SOLIDS. Liberman, David A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 171: 1-3(July 5, 1968). (LA-DC-9172).

The Hartree–Fock exchange potential for a uniform degenerate electron gas is adapted for use in atomic and solid-state calculations. Results are given for argon and mercury atoms. Energy eigenvalues are quite close to the Hartree–Fock values. (auth)

38782 CONFIGURATION INTERACTION INTEGRALS FOR Pu I AND II. Wilson, M. (Argonne National Lab., Ill.). Phys. Rev., 171: 4-7(July 5, 1968).

Configuration-interaction integrals connecting various configurations of atomic electrons in Pu I and II were calculated and their phases determined using nonrelativistic Hartree–Fock radial wave functions. It is shown that the strengths of certain types of these actinide interactions exhibit behavior similar to certain analogous interactions already known for simpler spectra. (auth)

38783 USE OF THE HARTREE–FOCK APPROXIMATION IN COMPUTING ELECTRON AFFINITIES. Lesk, Arthur M. (Princeton Univ., N. J.). Phys. Rev., 171: 7-10(July 5, 1968).

The implications are explored of a recently demonstrated theorem deriving upper bounds on the Hartree–Fock ground-state energy of a system consisting of N + 1 electrons in the potentials of a finite number of nuclei fixed in a bounded region of space, in terms of energies of single-determinantal wave functions for the system of N electrons in the identical nuclear framework. A conjectured generalization of the theorem is shown to be true. The application of the theorem to a criticism of computations on first-row atoms and ions is discussed, and it is concluded that the use of wave functions which do not satisfy the

theorem may be appropriate in the application of the Hartree–Fock approximation to the calculation of electron affinities of certain systems. (auth)

38784 MEASUREMENTS OF g_J RATIOS FOR ^{85}Rb, ^{87}Rb, HYDROGEN, AND DEUTERIUM, AND OF THE HYPERFINE SEPARATION OF DEUTERIUM. Hayne, G. S.; Ensberg, E. S.; Robinson, H. G. (Yale Univ., New Haven). Phys. Rev., 171: 20-31(July 5, 1968).

An optical pumping technique was used to measure atomic g-factor ratios among ^{85}Rb, ^{87}Rb, hydrogen, and deuterium, and the ground-state hyperfine separation in deuterium. An evacuated wall-coated optical absorption cell was employed for its advantages of a narrow and symmetric magnetic-resonance line shape. Measurements were carried out at applied magnetic fields of 7.6 and 14.5 G, and with both senses of circular polarization of the Rb pumping light. The Rb g_J ratios quoted are the averages of measurements for both ^{85}Rb and ^{87}Rb at both magnetic fields and both senses of circular polarization of the Rb pumping light, and the "extreme m_F" Zeeman transitions yielding the strongest Rb optical pumping signals were the ones measured with a given polarization sense. The results were $g_J(^{85,87}Rb)/g_J(H) = 1 + (23.6 \pm 0.4) \times 10^{-6}$, and $g_J(^{85,87}Rb)/g_J(D) = 1 + (23.5 \pm 0.3) \times 10^{-6}$. Comparing $g_J(Rb)/g_J(H)$ and $g_J(Rb)/g_J(D)$ measurements for specific Rb transitions yielded the ratio $g_J(D)/g_J(H) = 1 + (0.1 \pm 0.2) \times 10^{-6}$. The result for the measurement of the deuterium hyperfine separation was $\Delta\nu(D) = 327,384,352.6 \pm 1.2$ cps. (auth)

38785 BINDING ENERGY OF THE POSITRONIUM MOLECULE. Sharma, R. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 171: 36-42(July 5, 1968).

A suitable variational wave function has been used to obtain the binding energy of the positronium molecule, a stable complex consisting of two electrons and two positrons. We find the binding energy of the complex to be 0.948 eV. This shows that the previous calculations estimated the binding energy of the complex an order of magnitude too low. (auth)

38786 OPTICAL-POTENTIAL CALCULATION OF ELECTRON–HYDROGEN SINGLET SCATTERING. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). Phys. Rev., 171: 54-60 (July 5, 1968). (ORO–2915–86).

The use of the optical potential or self-energy of the single-particle Green's function for classic electron–atom scattering is discussed. The usual formalism, which assumes an unperturbed state described by a single determinant, is generalized to include unperturbed states described by a linear combination of determinants. Calculations are carried out for S-wave, elastic, singlet scattering of electrons by hydrogen atoms. The results are compared with the accurate variational calculations by Schwartz. (auth)

38787 INELASTIC SCATTERING CROSS SECTIONS FOR 200- AND 400-keV ELECTRONS. Dick, C. E.; Motz, J. W. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 171: 75-80 (July 5, 1968).

With 200- and 400-keV electrons incident on thin targets of aluminum, copper, tin, and gold, experimental data are given for the pulse-height distributions produced in a silicon detector by the electrons scattered at angles of 40°, 90°, 120°, and 140°. These distributions were analyzed to determine the inelastic cross sections integrated over the energies of the scattered electrons in the energy region below the elastic peak. This lower energy region involves energy transfers that are large compared to the atomic binding energies, and most probably involves atomic ionization processes. The results show that these inelastic scattering cross sections increase sharply for angles larger than 90°, so that the ratio of the inelastic to the elastic cross sections becomes larger than unity. In addition, these large-angle inelastic cross sections increase with the atomic number of the target and with the average binding energy per target electron. Because of the unavailability of accurate calculations for this process, comparisons are made with the Møller cross sections for electron–electron scattering in order to demonstrate how atomic binding effects influence large-angle inelastic scattering. (auth)

38788 SPIN EXCHANGE BETWEEN OPTICALLY ORIENTED METASTABLE HELIUM ATOMS AND THERMAL ELECTRONS IN A FLOWING AFTERGLOW. Schearer, L. D. (Texas Instruments Inc., Dallas). Phys. Rev., 171: 81-4(July 5, 1968).

The effects of spin-exchange collisions between thermal electrons and optically oriented metastable helium (2^3S_1) atoms have been observed in a flowing helium afterglow, and the exchange cross section has been measured. The source of electrons derives from Penning collisions between the 19.8-eV metastable atoms and impurity atoms which are titrated into the flow region. The presence of thermal electrons shortens the metastable-spin-state lifetime and reduces the magnitude of the optical-pumping resonance signal. The electron density is determined from the reduction of the metastable density. The exchange cross section is found to be $1.6 \pm 0.4 \times 10^{-14}$ cm^2. (auth)

38789 LYMAN-α PRODUCTION AND POLARIZATION IN He^+ COLLISIONS WITH H AND H_2. Young, Robin A.; Stebbings, R. F.; McGowan, J. William (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 171: 85-90(July 5, 1968).

The total cross section for Lyman-α production from $He^+ - H(1s)$ collisions was measured over the energy range from 0.5 to 30 keV. At the lower ion energies the cross section remains large. This probably reflects rotational interaction between certain states of the collision complex HeH^+. A similar result had been reported by Stebbings et al. for the $H^+ - H(1s)$ collision system. Also presented are measurements of the total cross section for Lyman-α production from $He^+ - H_2$ collisions. Some polarization values have been obtained for emission of Lyman-α from collisions of He^+, Ne^+, and Ar^+ with atomic hydrogen. (auth)

38790 ELECTRON–HYDROGEN SCATTERING CALCULATION. Armstead, Robert L. (Naval Postgraduate School, Monterey, Calif.). Phys. Rev., 171: 91-3(July 5, 1968).

Elastic electron–hydrogen scattering phase shifts for L = 1 are calculated from the Kohn variational principle, using up to 84 "Hylleraas-type" trial functions. Accuracy of the resulting phases varies from one to four significant figures, depending on the energy. A resonance appears in the ^3P wave at 9.727 eV. Elastic P-wave positron–hydrogen phase shifts are also calculated. (auth)

38791 MOBILITIES OF MASS-IDENTIFIED H_3^+ AND H^+ IONS IN HYDROGEN. Albritton, D. L.; Miller, T. M.; Martin, D. W.; McDaniel, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 171: 94-102(July 5, 1968).

The drift velocities of mass-identified H_3^+ and H^+ ions in hydrogen gas at room temperature were measured. The H_3^+ ions were found to be in thermal equilibrium with the gas at E/p_0 less than about 10 V/cm Torr; the H^+ ions, at E/p_0 less than about 5 V/cm Torr. From these measurements, the reduced zero-field mobilities were deduced: H_3^+, 11.1 ± 0.6 cm^2/V sec; H^+, 16.0 ± 0.8 cm^2/V sec. This investigation was performed with a long, low-pressure drift tube using a pulsed time-of-flight technique. The arrival-time histograms presented evidence of hydrogen ion–molecule reactions. It is shown that these reactions introduce no ambiguity in ascribing the above zero-field mobilities to single ionic species. Only a negligible fraction of the detected H_3^+ ions were formed by the three-body conversion of H^+ into H_3^+. Above an E/p_0 of about 54 V/cm Torr, the disruption of H_3^+ ions contributes substantially to the H^+ signal. The reactive formation of H_5^+ from H_3^+ was evident in the H_5^+ arrival-time histograms. The zero-field mobility of potassium ions in hydrogen was also determined, and the close agreement with the data of other investigators demonstrates that the apparatus is relatively free of unknown systematic uncertainties. (auth)

38792 LOW-ENERGY (1- TO 100-eV) CHARGE-TRANSFER CROSS-SECTION MEASUREMENTS FOR NOBLE-GAS-ION COLLISIONS WITH GASES. Mahadevan, P. (McDonnell Douglas Corp., Huntington Beach, Calif.); Magnuson, G. D. Phys. Rev., 171: 103-9(July 5, 1968).

Cross sections for charge transfer between positive ions and atoms and molecules were measured in the low-energy range (1 to 100 eV), using direct-current techniques for slow-product-ion detection. The electrode configuration adopted is designed to discriminate against elastically scattered primary particles. Resonant symmetric systems such as $He^+ + He$ and $Ar^+ + Ar$ and near-resonant pairs like $He^+ + N_2$ and $He^+ + O_2$, respectively, were investigated. Cross-section functions for the symmetric cases conform to an expression of the form $\sigma^{1/2} = a - b \ln E$. Other reactions studied include Ar^+ in N_2 and H_2 and the inverse reactions $Ar^+ + He$ and $He^+ + Ar$, respectively. Results are compared with existing literature values. (auth)

38793 POSSIBLE RESONANCE IN POSITRON–HYDROGEN SCATTERING. Drachman, Richard J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 171: 110-14(July 5, 1968).

The positron–hydrogen system is considered, with the view to determining whether a scattering resonance below the positronium threshold is likely to occur, as has been suggested by Bransden and Jundi. The likeliest mechanism for producing such a resonance would be the existence of a virtual bound state in the positronium–proton channel, brought about by the large dipole polarizability and mass of the positronium atom. A modification of Holøien's technique enables one to reject spurious solutions without the use of the projection-operator technique. A nonvariational adiabatic calculation seems to indicate that a resonance does exist, lying at 0.1 eV below the threshold. When, however, a variational treatment is

employed, certain essential nonadiabatic terms appear. The resultant reduction in attraction serves to eliminate the apparent resonance. It is concluded that the previously reported resonance is probably an artifact. (auth)

38794 MEASUREMENT OF HIGH-ENERGY CHARGE-TRANSFER CROSS SECTIONS FOR INCIDENT PROTONS AND ATOMIC HYDROGEN IN VARIOUS GASES. Toburen, L. H.; Nakai, M. Y.; Langley, R. A. (Oak Ridge National Lab., Tenn.). Phys. Rev. 171: 114-22(July 5, 1968). (ORNL-P-3683).

Measurements of electron-capture cross sections σ_{10} and electron-loss cross sections σ_{01} for protons and atomic hydrogen in H_2, He, Ar, Kr, N_2, O_2, CO, CO_2, H_2O, CH_4, C_2H_4, C_2H_6, and C_4H_{10} are reported and compared with published theoretical estimates and experimental results. The energy range was 100 to 2500 keV. The results are presented in graphical form. By applying the additive rule, the cross sections σ_{10} and σ_{01} are estimated for hydrogen particles in carbon. (auth)

38795 ANGULAR DEPENDENCE OF 2^3S EXCITATION OF He BY HIGH-ENERGY ELECTRON IMPACT. Kang, Ik-ju; Choi, Chan Kyoo (Southern Illinois Univ., Carbondale). Phys. Rev., 171: 123-5(July 5, 1968).

Electron impact excitation of metastable He atoms is formulated in the Coulomb-wave approximation. At high energy, both the direct and the exchange scattering amplitudes are approximated in closed analytic forms, which are identical to the Born–Oppenheimer approximation apart from the core potential contribution. From these expressions, the validity of the Ochkur approximation and its limitations are discussed. Also obtained is the forward-peaking differential cross section for He(2^3S) excitation, which is in qualitative agreement with the recent experiment by Vriens, Simpson, and Mielczarek. Thus an explanation for the observed angular behavior of the cross section is offered for the first time. (auth)

38796 STOPPING POWERS OF ^{32}S, ^{35}Cl, ^{79}Br, AND ^{127}I IONS IN MYLAR. Pierce, T. E.; Bowman, W. W.; Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev., 172: 287-90(Aug. 10, 1968).

Stopping powers of Mylar are presented for ^{32}S ions of mean energy 15 to 95 MeV, ^{35}Cl ions of 15 to 95 MeV, ^{79}Br ions of 30 to 90 MeV, and ^{127}I ions of 60 and 105 MeV. The heavy-ion beams were accelerated on the Rochester MP tandem Van de Graaff; energies were known to ±50 keV. The precision of energy-loss measurements was of the order of 2% with an estimated accuracy of ±8%. The experimentally determined stopping powers were used with the Bethe–Bloch equation and experimental proton stopping powers to calculate effective charges. The fractional effective charges for the ions investigated all fit a single smooth curve when compared with a reduced velocity variable; published values for ^{16}O-ion stopping powers in carbon and aluminum yielded effective charges that fit the same curve. The effective charges for ^{32}S, ^{79}Br, and ^{127}I are compared with the experimental most probable charge states, and are found to be less than the experimental values in all cases. This variation at its greatest is found to be 67%. (auth)

38797 ROTATIONAL CORRELATION FUNCTIONS IN NEUTRON SCATTERING BY MOLECULAR GASES. Agrawal, Ashok K.; Yip, Sidney (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 171: 263-71(July 5, 1968).

The incoherent neutron scattering cross section of molecular gases is evaluated in terms of classical rotational time correlation functions. The calculation emphasizes the Gaussian behavior of the intermediate scattering function but also treats non-Gaussian effects. Explicit expressions applicable to spherical, linear, and symmetric molecules are given and applied to CH_4, HCl, and NH_3. Comparisons with exact quantum-mechanical calculations and experimental data show the Gaussian approximation to be reasonably accurate. In the case of CH_4, the inclusion of the leading non-Gaussian term brings the agreement to within about 1% of the exact results. The present approach considerably reduces the amount of computation relative to exact calculations; moreover, it permits a physically intuitive and potentially tractable extension to liquids and solids. (auth)

38798 SEMI-EMPIRICAL CALCULATION OF THE INELASTIC SCATTERING OF ELECTRONS ON ATOMS. Eletskii, A. V.; Smirnov, B. M. (Moscow Power Engineering Inst.). Zh. Tekh. Fiz., 38: 3-7(Jan. 1968). (In Russian).

The semiempirical formula $s = (2\pi f/\Delta E^2)F(E/\Delta E)$ is proposed for calculating the cross sections for excitation of an atom by electron impact. Here f is the oscillator strength of the atomic transition, ΔE is the excitation energy of the atom (the energy transfer in the collision), E is the incident electron energy, F is an (approximately) universal function of its argument $E/\Delta E$, and all quantities are measured in atomic units ($\hbar = m = e^2 = 1$). The authors arrived at their formula by considering the Born approximation, which gives $F(x) = (\log x)/x$ for large values of $x = E/\Delta E$. The formula was compared with calculated cross sections for excitation of hydrogen and hydrogen-like atoms and experimental cross sections for excitation of alkali metal atoms, and it is concluded that the function $F(x) = (\log(Ax + B))/(x + D)$ with A = 0.1, B = 0.9, and D = −0.7 gives reasonably accurate results. (ATD)

38799 MEASUREMENT OF X-RAY EXTERNAL PHOTOEFFECT QUANTUM YIELDS IN WAVELENGTH REGION 1 TO 10A. Eliseenko, L. G.; Shchemelev, V. N.; Rumsh, M. A. (Leningrad State Univ.). Zh. Tekh. Fiz., 38: 175-83(Jan. 1968). (In Russian).

The authors measured the $K_T = I/eN$, $K_x = i/eN$, and $K_p = n/N$ quantum yields (e is the electron charge, N is the number of x ray photons incident on the target per unit time, I is the total photoelectric current, i is the photoelectric current measured with a certain retarding potential on the collector grid and ascribed to photoelectrons and Auger electrons, and n is the number of photoemission events recorded per unit time with a secondary electron multiplier) for Cu, Co, Fe, Cr, Ti, Ca, Si, Al, and Mg K_α and Ag, Mo, and Zr L_α x rays incident onto Al, Ti, Cu, Te, Sn, Au, Pb, LiF, NaF, NaCl, CaF_2, KCl, SrF_2, KBr, KI, RbCl, CsCl, and CsI targets vacuum deposited onto glass or plastic substrates. The results are tabulated and discussed. The target-thickness dependence of K_p for CsI targets indicated that the x ray photoeffect takes place at considerable depths in the target (at about 1000 Å for Mg K_α radiation). All three quantum yields for all the targets increased with increasing wavelength, but with discontinuities associated with adsorption edges. K_T was always much greater than K_x or K_p. K_x was usually greater than K_p for the metal targets, but K_p was always greater than K_x for the dielectric targets. The relative number $(K_p - K_x)/K_p$ of purely secondary emission events increased with increasing wavelength for all the dielectric targets except LiF, and reached 90% for CsCl and CsI targets at 10 Å. Implications of these and other regularities exhibited by the data are discussed briefly. (ATD)

38800 THEORETICAL DETERMINATION OF LINEAR ENERGY TRANSFERS OF RADIATIONS IN CERTAIN DIELECTRIC LIQUIDS. EXPERIMENTAL MEASUREMENTS. Blanc, D.; Mathieu, J.; Patau, J. P. (Faculte des Sciences, Toulouse). pp 681-717 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968. (In French).

See EUR-3747; CONF-671109.

The mathematical principle on which evaluations are made of linear energy transfers of electrons, gamma rays, protons, and fast neutrons in dielectric liquids such as n-alkanes, cyclohexane, benzene, toluene, carbon tetrachloride and carbon sulfide is discussed. These liquids can be used to fill special ionization chambers. A description is given of such a chamber with plane beryllium electrodes and Perspex walls. In a stable particle beam, the abscissa of the point of convergence of the plateau with the axis of the electric field is characteristic of the QF of the radiation. The numerical results are used to correlate the value of this abscissa with that of the linear energy transfer of this radiation. (auth)

38801 BUILDUP AND EQUILIBRIUM OF SECONDARY ELECTRONS FOR HIGH-ENERGY ELECTRON RADIATION. Harder, D.; Schulz, H. J. (Univ., Wuerzburg, Ger.). pp 385-407 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.

See EUR-3747; CONF-671109.

Depth-dependent secondary electron spectra of a 10–20 MeV primary electron beam in several absorbing media are investigated by computation and experiment. Methods and first results are reported. Considering more or less exactly the initial energies and directions as well as the slowing down and scattering of the secondaries the computation is performed to different degrees of approximation. A magnetic spectrometer with 90° deflection, which separates the secondaries from the primaries immediately behind the absorber layer, is used for experimental observation. The spectrometer is equipped with a thick layer semiconductor detector that permits the discrimination of bremsstrahlung and stray electron background pulses. (auth)

38802 ESTIMATION OF THE LOCAL ENERGY LOSS DISTRIBUTION OF IONIZING RADIATION FROM OBSERVATIONS OF ION RECOMBINATION IN A GAS. Sullivan, A. H. (CERN, Geneva). pp 295-312 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert,

H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

The initial recombination of ions in a gas depends on the ion density along the tracks of charged particles. A method is described that uses this phenomenon to obtain information about the initial ion density distribution in the gas. Existing theories of columnar and cluster recombination are examined and it is shown that with the right conditions in an ionization chamber the cluster theory may be considered universal. The theory can then be used to interpret the current versus voltage characteristic of an ionization chamber in terms of energy absorbed and the size of the ionizing events. An ionizing event is defined by the theory, and ranges from a point cluster of ions to the ions occurring along a segment of the track of a charged particle equivalent to about 0.08 μ in tissue. The experimental and theoretical problems involved in the method are discussed. (auth)

38803 CALCULATION OF ENERGY DEPOSITION SPECTRA. Kellerer, A. M. (Univ., Munich. Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). pp 57-77 of Proceedings on the Symposium on Microdosimetry, Ispra, Italy, November 13-15, 1967. Ebert, H. G. (ed.). Brussels, Euratom, 1968.
See EUR-3747; CONF-671109.

Classical straggling theory is of limited applicability in microdosimetry. A new derivation of the energy loss distributions and some theoretical properties of the Compound Poisson process are discussed. (auth)

38804 BOUNDS ON CROSS SECTIONS. Spruch, L. (New York Univ., N. Y.). Contract Nonr-285(49). pp 89-107 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

A review of the field of bounds in collision physics is presented. Consideration is given to those bounds on scattering parameters, such as scattering lengths and phase shifts, which determine cross sections. The topics discussed are: simple bounds, variational bounds for zero incident energy, the scattering length phase, bounds and variational bounds for nonzero incident energies, and the other bound on scattering parameters. (TSS)

38805 INTEGRAL EQUATIONS FOR THE THREE-PARTICLE SCATTERING PROBLEM. Faddeev, L. D. (Steklov Mathematical Inst., Leningrad). pp 145-9 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

For an approach to the three-particle problem in quantum scattering theory, the exact integral equations and practical methods for their solution are discussed. (TSS)

38806 COLLISION PROCESSES IN THE ARGON ION LASER. Bennett, W. R. Jr. (Yale Univ., New Haven). Contract DA-31-124-ARO-D-124. pp 61-85 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The large charged-particle and excited state densities in the argon ion laser have made it possible to study a number of collisional excitation processes. Measurements of the radiative lifetimes and direct electron excitation cross sections, analyses of line shape and broadening mechanisms, and studies of characteristic velocity distributions for multistep processes and drift velocities for the argon ion laser are presented and discussed. (TSS)

38807 COLLISION PROCESSES RELEVANT TO AERONOMY. Donahue, T. M. (Univ. of Pittsburgh). pp 32-48 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

Mechanisms accounting for the ionic composition of the upper atmosphere are considered as they relate to atomic collision phenomena. The role of the following processes in the formation and depopulation of He^+, O^+, H^+, NO^+, N^+, N_2^+, O_2^+, and electrons in ionospheric layers are discussed: photodissociation, ionization, dissociative recombination, thermal diffusion, ion-molecule reactions, solar effects, and transport processes. Their significance to ionospheric ion distribution variations is evaluated in terms of reaction rate coefficients with flow diagrams to represent steady-state conditions. Various reactions are suggested to account for discrepancies in the expected and measured ionospheric ion distribution. It is suggested that the dependence of reaction rates on vibrational excitation needs exploring. (TSS)

38808 ROLE OF ATOMIC COLLISION PROCESSES IN ASTROPHYSICS. Branscomb, L. M. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). pp 12-31 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The relevance of atomic collision processes to current problems in astrophysics is discussed. Topics considered are stellar structure and spectra and the interstellar medium. In the former, the existence or nonexistence of local thermodynamic equilibrium (LTE) may be applied to the problem of the stellar continuum for the development of the source function in the radiative transfer equation. Attention is given to the influence of the H^- continuum on the spectra of stars as it develops from these collision processes: excitation, mutual neutralization, and associative detachment. The contribution of collisional excitation to the shape of the calcium and helium ion resonance lines in stellar spectra is pointed out. The properties of the solar corona are indicated to be determined by electron excitation cross sections for excitation and ionization of highly ionized atoms. Applications of collision processes to solutions to questions of the properties and formation of interstellar materials and planetary nebulae are discussed. It is suggested that cross section information may be used to determine the temperature and density of the H II region. Other astrophysical problems are described. (TSS)

38809 CROSS SECTION MEASUREMENTS NEEDED FOR CONTROLLED FUSION RESEARCH, MHD GENERATORS, AND OTHER PLASMA STUDIES. Golovin, I. N.; Kasabov, G. A.; Kogan, V. I.; Smirnov, B. M. (Kurchatov Inst. of Atomic Energy, Moscow). pp 3-11 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

An evaluation is made of the necessity and relevance of more reliable cross section calculations of various elementary processes in the development of plasma physics and its application to astrophysics, controlled fusion, MHD power conversion, gas lasers, etc. A set of "reference points" are considered which would permit the derivation of sufficiently reliable theoretical and empirical formulas enabling one to predict the values of cross sections with adequate accuracy in the regions which are still difficult to study. (TSS)

38810 THE PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS. Invited Papers from the Fifth International Conference, Leningrad, July 17-23, 1967. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968. 214p. (CONF-670702-(Vol.1)).

Fifteen papers of three types are presented: (1) application of atomic collision physics to other fields; (2) special topics in collision physics; (3) and appraisal and outlook for collision physics. Separate abstracts were prepared for 14 papers. (TSS)

For abstracts of individual papers see: 38804-38809 and 38811-38818.

38811 UTILITY AND VALIDITY OF THE IMPACT PARAMETER METHOD. Wilets, L. (Univ. of Washington, Seattle). pp 108-21 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The eikonal approximation for potential scattering in atomic collisions is reviewed. Expressions for differential cross sections are developed from considerations of the impact parameter, and calculations are compared with semiclassical results for proton-hydrogen scattering. It is pointed out that the eikonal method gives a method for converting semiclassical calculations into fully quantal calculations without determining the necessary effective potential for Coulomb trajectories. (TSS)

38812 CURRENT PROBLEMS IN THE EXPERIMENTAL STUDY OF ELECTRONIC AND ATOMIC COLLISIONS. Hasted, J. B. (University Coll., London). pp 194-200 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.
From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The impact that new experimental techniques are likely to have on collision studies and the directions which such studies might take are discussed. (TSS)

38813 THEORETICAL ASPECTS OF ATOMIC COLLISIONS: HEAVY PARTICLE COLLISIONS. Demkov, Yu. N. (Leningrad State Univ.). pp 186-93 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

A review of conference papers relating to recent developments in heavy-particle collision theory is presented. Studies made of the behavior of potential curves of quasi molecules in the theory of slow atomic collisions are emphasized, specifically, with respect to the implications of adiabaticity, curve crossing and pseudo-crossing for quasi-stationary states, symmetry, collective vibrations, and analytical properties of potential functions. Listings of papers devoted to various other processes are also given. (TSS)

38814 THEORETICAL ASPECTS OF ATOMIC COLLISIONS: CLASSICAL, VARIATIONAL, AND FADDEEV METHODS. Gerjuoy, E. (Univ. of Pittsburgh). Contracts NGR-39-011-035; DA-31-124-ARO-D-440. pp 175-85 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The activity and recent developments in three topics of atomic collision theory are discussed as exemplified by papers presented at the conference: (1) classical methods; (2) variational methods and bounds; (3) and Faddeev equations. (TSS)

38815 THEORETICAL ASPECTS OF ATOMIC COLLISIONS: ELECTRON COLLISIONS. Drukarev, G. F. (Leningrad State Univ.). pp 163-74 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

A summary is presented of the general situation in the theory of elastic and inelastic electronic collisions with atomic systems (atoms, ions, molecules), and ionization of atomic systems by electrons and photons. Consideration is given to three kinds of problems: (1) calculation of the cross section for a particular process (elastic scattering, excitation, ionization), the final state of all electrons being exactly specified; (2) determination of the smoothed cross sections in which the fine structure is washed out; and (3) the calculations of the cross section which corresponds to a particular energy and momentum transfer rather than to a particular final state. (TSS)

38816 IONIZATION OF THE INNER SHELLS OF ATOMS. Fano, U. (Univ. of Chicago). pp 150-9 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

Information available on the excitation and ionization of the internal shells of atoms is outlined. Special attention is given to the problem of the photoabsorption of inner-shell electrons, specifically with the departures from the predictions of the hydrogenic approximation in the energy range below 1 keV. (TSS)

38817 THEORETICAL BACKGROUND AND ACHIEVEMENTS OF THE CLOSE-COUPLING APPROXIMATION. Burke, P. G. (Queen's Univ., Belfast). Contract F61052-68-C-0012. pp 128-44 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

The theoretical basis of the close-coupling approximation, the various applications that have been made, and the reliability of the results for calculations of low-energy scattering of electrons by light atomic systems are summarized. (TSS)

38818 APPROXIMATION METHODS FOR CALCULATING CROSS SECTIONS FOR EXCITATION OF ATOMS BY ELECTRONS. Vainshtein, L. (Lebedev Physical Inst., Moscow). pp 122-7 of Physics of Electronic and Atomic Collisions. Branscomb, Lewis M. (ed.). Boulder, Colo., Univ. of Colorado, 1968.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR. See CONF-670702-(Vol.1).

Approximation methods based on the Born Approximation frequently do not yield good results for excitation cross sections. An evaluation of the difficulties of these methods is presented. A method is suggested which takes into account the repulsion between the incident and atomic electrons, and simpler formulae are presented for calculations for transitions in the second Born Approximation. (TSS)

38819 DETERMINATION OF MUONIUM HYPERFINE INTERVAL THROUGH MEASUREMENTS AT LOW MAGNETIC FIELD. Thompson, Patrick Andrew. New Haven, Yale Univ., 1967. 137p. Thesis.

An important test of the validity of the application of quantum electrodynamics to the muon is a comparison of the theoretical hyperfine structure splitting ($\Delta\nu$) of the muonium atom (μ^+e^-) with an experimental measurement of this quantity. Previous experiments at fields of about five kilogauss have given agreement between the theoretical and experimental values. A measurement of this quantity at low (less than 10 gauss) fields involves different experimental techniques and thus provides a check of the high field measurement. Experimental measurements have been made of this quantity at fields of about 3 gauss and 13 milligauss, by observing microwave transitions between magnetic sublevels of the ground state of the muonium atom. The measured value $\Delta\nu = 4463.19 \pm 0.06$ Mc/sec is in good agreement with the previous measurement at high field. Assuming that the theory is well understood, a value of the fine structure constant α may be determined from these measurements. This value is $\alpha^{-1} = 137.0388 \pm .0014$. The measurements at 13 milligauss coupled with a theoretical calculation of the line shape at this field have established the usefulness of measurements at fields of this magnitude for future experiments. This is of importance because the experimental signal is four times as large for milligauss fields as it is for fields of a few gauss. (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 37996, 38022, 38112, 38653, 38659, 38880, 39252, 39254, 39262, 39263, and 39427.

38820 (AD-664355) CHERENKOV LIGHT EXPERIMENT: BOLIVIAN AIR SHOWER JOINT EXPERIMENT. Final Technical Report. Bradt, H. V.; Krieger, A. S. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Jan. 1968. 29p. (AFOSR-68-0179). CFSTI.

The report contains a description of the atmospheric Cherenkov light detectors on Mt. Chacaltaya, Bolivia. The experimental considerations governing the design of the apparatus are discussed and the experimental equipment is described. (auth) (USGRDR)

38821 (AD-668483) ATMOSPHERIC AND LEAKAGE FLUX OF NEUTRONS PRODUCED IN THE ATMOSPHERE BY COSMIC RAY INTERACTIONS. Report No. Scientific-3. Boella, G.; Dilworth, C.; Panetti, M.; Scarsi, L. (Milan Univ. (Italy). Istituto di Scienze Fisiche). Dec. 15, 1967. Contract AF61(052)-808. 38p. (AFCRL-68-0173). CFSTI.

The curve of the integrated neutron flux in the 'thermal' to 20-MeV energy range, as a function of the atmospheric depth from sea level up to 0.1 mbar, has been obtained, assuming as energy spectrum that predicted by Newkirk. The instrument employed is a combination of an hydrogeneous moderator with a slow neutron detector, with anticoincidence rejection of background events. Four balloon flights were carried out in March 1966, one rocket flight in July 1966. With this flight the curve has been extended to 0.1 mbar from 6 mbar, attained with the balloon flights. The neutron flux as a function of the atmospheric depth is given, at 5.3 GV geomagnetic cutoff rigidity, in quiet Sun conditions. (auth) (USGRDR)

38822 (N-68-11830) RADIATION MONITORING WITH NUCLEAR EMULSIONS ON PROJECT GEMINI. 3. THE FLUX OF GALACTIC HEAVY PRIMARIES ON GEMINI 7. Schaefer, Hermann J.; Sullivan, Jeremiah J. (Naval School of Aviation Medicine, Pensacola, Fla.). Sept. 29, 1967. 17p. (NASA-CR-90107; NAMI-1017). CFSTI.

Earlier evaluations of small nuclear emulsion sheets flown on the astronauts' bodies during the 14-day Gemini 7 mission had been limited to grey tracks which allowed grain counting. This report provides data on the population of heavy tracks. By comparing visual appearance of the diameter of the solid silver core and of the delta ray aura with tracks of known Z, tracks of $Z \geq 20$ were identified and counted. A total of 287 such tracks yielded a mission flux of 38.4 nuclei/cm^2 of $Z \geq 20$, corresponding to a tissue dose of 1.35 millirads. Theoretical assessment of the flux by considering the geomagnetic latitude profile of the mission leads to 74.8 nuclei/cm^2 of $Z \geq 20$. The difference closely matches the expected attenuation due to the inherent shielding of the vehicle and the self-shielding of the astronauts' bodies if one assumes a collision mean free path of 14 g/cm^2 for nuclei of $Z \geq 20$. The results confirm earlier estimates that galactic heavy nuclei contribute less than 5% to the total absorbed dose. (auth) (STAR)

38823 (N-68-16723) PROTON AND HELIUM NUCLEI COSMIC RAY SPECTRA AND MODULATIONS BETWEEN 100 AND 2,000 MeV/NUCLEON. Ormes, Jonathan F. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Dec. 1967. 94p. (NASA-CR-92991; CR-109). CFSTI.

Convolution techniques are used to unfold the Landau fluctuations in energy loss thereby allowing derivation of the differential energy spectrum from 100 MeV/nucleon up to 2 BeV/nucleon. The differential energy spectra derived by this technique are presented from nine balloon flights, five at Fort Churchill, Canada and four at latitudes ranging from Ely, Minnesota to Fayetteville, Arkansas. The spectra at lower latitudes clearly show the effects of the geomagnetic cutoff. The data are examined to determine the functional form of the solar modulation by comparing the sunspot minimum spectrum obtained in 1965 with the pre-sunspot minimum spectrum obtained in 1963 and the post sunspot minimum spectrum obtained in 1966. (auth) (STAR)

38824 (N-68-19937) COMMENT ON THE BIOLOGICAL EFFECTS OF COSMIC RAYS FROM NEARBY SUPERNOVAE. Laster, H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Feb. 1968. 5p. (NASA-CR-93745; TR-800). CFSTI.

Current theories describing cosmic ray propagation within the galaxy say that particles are either diffusing through the interstellar medium or moving along tortuous galactic magnetic lines. In either case, approximately three light years is taken as typical for straight line propagation of cosmic-ray particles from their source; and, because of these paths, radiation would be spread over years rather than occur in a sudden burst. Therefore, the biological effect for supernovae emission is considered to be appreciably smaller than that described by Terry and Tucker, and effects on animals would probably be negligible. Based on a diffusion model with mean free paths of about three light years, an average of 40 years is estimated for a supernova explosion in 6×10^8 years that produces 25,000 roentgens and releases 10^{50} ergs. Even with 10^{51} ergs cosmic-ray energy, biological effects would be appreciably reduced for all but the very closest and rarest of supernovae. Doses of 10,000 roentgens are estimated to occur once every 150 million years, with each dose spread over hundreds of years. (STAR)

38825 (N-68-21534) INTENSITY AND TIME VARIATION OF PRIMARY COSMIC RAY ELECTRONS. Simnett, G. M. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1968. 37p. (NASA-TM-X-63162; X-611-68-108). CFSTI.

The primary cosmic-ray electron differential energy spectrum between 30 and 1500 MeV was measured with a system composed of a Cherenkov telescope and a lead-scintillator sandwich detector. Results are presented from a balloon flight made at Kiruna, Northern Sweden, in 1967, and these are compared with measurements made in 1965 with a similar detector. The results are well represented by a power law spectrum between 150 and 800 MeV. There is evidence for a rigidity-independent (solar) modulation of the electron flux below 600 MeV, which is the highest energy where the results are comparable. The lower limit to the modulation is 20%. There is no evidence for a diurnal variation in the electron intensity. The results of other comparable balloon borne electron experiments are discussed. (auth) (STAR)

38826 (N-68-21755) STUDY OF COSMIC RAYS IN THE SOLAR ENVIRONMENT. Final Technical Report. (Aeronautical Research Associates of Princeton, Inc., N. J.). Oct. 1967. Contract NAS5-9394. 10p. (NASA-CR-94129). CFSTI.

The major objective of the research is to establish the correct equations that govern the behavior of cosmic rays (both of solar and of galactic nature) in the presence of the solar environment plasma. The ultimate aim is that of constructing the transfer function that relates the local cosmic beam with that in interstellar space. At every stage in the inference, close comparison is to be made between the theoretical deductions and the observations available. Suggestions concerning pertinent observations are made wherever possible. Papers prepared during the year towards this objective are summarized. A major outcome is an estimate of the interstellar spectrum of cosmic rays and of the x radiation expected from H I clouds as a consequence of the energy transferred to them by the cosmic rays. (auth) (STAR)

38827 MUON INTENSITIES DEEP UNDERGROUND. Larson, Michael Oberlin. Salt Lake City, Univ. of Utah, 1968. 84p.

Thesis.

Muon intensities at depths greater than 1700 hg/cm^2 were studied using the University of Utah neutrino detector at Park City, Utah. The overburden provides a continuous range of depths from 1700 hg/cm^2 to 8000 hg/cm^2 in the zenith angle range of 40 to 80°. The trajectories of 14,543 muons were analyzed with an accuracy of ±0.5° in azimuth angle and ±1.0° in zenith angle. A concurrent experiment indicated that there was no significant zenith angle dependence to the muon spectrum for energies greater than 5×10^{11} eV. Thus, a muon depth-intensity plot could be constructed using all muons independent of the zenith angle at which they entered the detector. Such a plot is presented using the 14,543 muons divided as to the amount of rock they traversed in reaching the apparatus. A comparison with previous depth-intensity measurements is made and good agreement found, particularly in the region around 2000 hg/cm^2 where previous workers have amassed considerable data. The present work increases by an order of magnitude the data on the vertical muon depth-intensity curve above 2000 hg/cm^2. (Disser. Abstr.)

38828 ON THE SPECTRUM OF RELATIVISTIC ELECTRONS ACCELERATED IN COSMIC-RAY SOURCES. Ginzburg, V. L.; Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci., 1: 442-50(June 1968).

The data on the spectrum of the cosmic-ray electron component near the Earth, on the radio-spectra of radio-galaxies, quasars and the Crab Nebula, as well as the data pertaining to the x-ray spectrum of the cosmic background, all agree that the sources of cosmic-ray electrons (such as supernovae and galactic nuclei) inject particles characterized by a power spectrum $N(E) = KE^{-\gamma_0}$, with $\gamma_0 \simeq 1.5-2.5$. A mechanism is known in which the source emits a proton-nuclear component of cosmic rays with a spectrum $N_n(E) = K_n E^{-\gamma_n}$, $\gamma_n = \delta + 2$, $\delta = w_{CR}/(w - w_{CR})$, where w_{CR} is the cosmic-ray energy density in the source, and $w = w_{CR} + w_N + w_{turb}$, the total energy density. $\gamma = 2.5$ is obtained in agreement with observations on the natural assumption that $\delta = 0.5$. Within the framework of the same model with some additional assumptions, the electrons in the source, as well as those ejected by the source, are shown to have a power-spectrum characterized with $\gamma_0 \leq \gamma_n = \delta + 2$. Thus the model discussed gives an adequate spectrum for both the proton-nuclear and the electron components of cosmic rays. (auth)

38829 SPATIAL AND TEMPORAL RESOLUTION OF MULTI-JOULE EXTENSIVE AIR SHOWERS BY MEANS OF ATMOSPHERIC FLUORESCENCE. Landecker, Peter Bruce. Ithaca, N. Y., Cornell Univ., 1968. 120p.

Thesis.

The objectives of the experiment described in this thesis are to extend the cosmic-ray spectrum and record the incident direction and energy of rare primary cosmic rays in the energy range from 10^{17} to 10^{21} eV and to extract the astrophysical and cosmological implications associated with the data. A detector located near Cornell University will be capable of recording the faint fluorescent light signal emitted isotropically in the wake of a very large extensive air shower. The very sensitive optical recording system will be able to track the shower path across the sky as a function of time. The detector system when completed will consist of a mosaic of 505 2-inch diameter photomultiplier tubes clustered in the focal surfaces of 16 large fresnel lenses and will be housed in a 16-sided semi-regular convex polyhedron structure. To image the entire sky, each phototube will look at a different 0.01 str sector of the sky. The apparatus will therefore have an angular resolution of about 3° which, although not fine enough to record the fine shower structure of a giant air shower, will be able to observe its development in time and space. A trail of light in the night sky produces a sequence of pulses in a line of phototubes with time separation inversely proportional to the apparent angular velocity of the source. The recording system is activated when there is a pulse above threshold in one channel and a delayed pulse in an adjacent channel following within a time slightly greater than the width of the first pulse. When triggering occurs, the slightly delayed pulses in all channels are displayed on an array of 3-inch cathode ray tubes (one for each photomultiplier) and photographed on 70 mm film. Calibration lamps and time markers provide an instantaneous gain and time calibration in all channels for each event. The electronics and hardware used in a pilot version of this experiment are discussed in detail. Relevant spectral characteristics, expected signal and noise levels, and the expected counting rates are discussed. An artificially produced simulated inverse air shower is analyzed after being recorded by a pilot detector system consisting of a cluster of 37 photomultipliers. Future experimental plans are discussed. (Disser. Abstr.)

38830 ZENITH-ANGLE DEPENDENCE OF THE MUON FLUX DEEP UNDERGROUND. Martin, Elgin Ray. Salt Lake City, Univ. of Utah, 1968. 100p.

Thesis.

Utilizing approximately ⅔ of the kiloton neutrino detector in Park City, Utah, data were gathered on the trajectories of about fifteen thousand high-energy muons to an accuracy of 0.2° in

azimuth and 1.0° zenith. The 1800-foot rock overburden guarantees muon energies of 10^{12} eV and above, and permits an excellent determination of the zenith-angle dependence of the muon intensity spectrum. The observed data are compared with predictions on the basis of the usual pion and kaon parentage, with strong disagreement indicated. A model of a new production process is given and compared with the data, which indicate that at these muon energies, K and π mesons account for only a small fraction of the total underground muons, the rest presumably coming from a direct-production process or a new, very short-lived, parent. Discrepancies between previous experiments which inferred the muon spectrum indirectly from other measurements, and the direct measurements of the present experiment are discussed. (Disser. Abstr.)

38831 DIFFUSION OF COSMIC PARTICLES IN THE INTERPLANETARY MEDIUM. Dolginov, A. Z.; Toptygin, I. M. (Ioffe Inst of Physics and Tech., Leningrad. Leningrad Polytechnic Inst.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 785-90(1967). Translated from Geomagn. Aeron., 7: 967-73(1967).

An equation was derived from the Boltzmann kinetic equation that describes the diffusion of cosmic rays in the magnetic field of interplanetary space. It is assumed that in addition to the regular magnetic field component there is a random component that fluctuates in space and time and that the field fluctuations can move in space with some speed. An explicit analytical expression is obtained for the distribution function of cosmic particles in the random magnetic field for a constant diffusion coefficient. (auth)

38832 MEASUREMENTS OF THE ABSOLUTE INTENSITY OF THE PRIMARY AND SECONDARY COSMIC-RAY COMPONENTS IN SPACE NEAR THE EARTH. Charakhch'yan, A. N.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ. Inst. of Nuclear Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 791-3(1967). Translated from Geomagn. Aeron., 7: 974-7(1967).

Experimental data on the intensity of the primary and secondary (albedo) components of cosmic rays in space near the Earth are analyzed. The absolute intensities of these components are given for various geomagnetic latitudes. (auth)

38833 DENSITY OF SLOW NEUTRONS AT VARIOUS DEPTHS OF THE ATMOSPHERE IN YEARS OF MINIMUM SOLAR ACTIVITY. Romanov, A. M. (Ioffe Inst. of Physics and Tech., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 883-4(1967). Translated from Geomagn. Aeron., 7: 1089(1967).

The intensity variations of neutrons in the atmosphere are a sensitive indicator of variations in the intensity of galactic and solar cosmic rays. Of interest in this respect are the results of measurements of the density of slow neutrons ($E \leq 10$ keV) at various depths in the atmosphere in years of minimum solar activity and their comparison with data obtained in other periods of the 11-year cycle. The measurements were conducted in March 1964 and in March 1965 at geomagnetic latitude $\lambda = 57°$N. (W.D.M.)

38834 ALTITUDE DEPENDENCE OF COSMIC-RAY INTENSITY IN THE ATMOSPHERE. Takeuchi, Hajime. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1262-8(Sept. 1966). (In Japanese).

The altitude variation of cosmic-ray intensity in the atmosphere was analyzed, so as to check the flux value obtained by means of single counters carried by rockets and satellites. The main material used is that obtained by a single counter in the rockoon system in its balloon phase. The vertical intensity deduced from that was compared with intensities obtained by counter telescope experiments, and proved to be consistent, except that there were some systematic deviations probably caused by the difference of the threshold energies and of the low-energy γ-ray efficiency. (Meteorol. Geoastrophys. Abstr.)

38835 ELECTRONS AND GAMMA RAYS IN THE SPACE UNDER THE INNER RADIATION BELTS. Miyazaki, Yukio. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1256-61(Sept. 1966). (In Japanese).

Derivation from the data obtained by G-M counters of directional intensity of cosmic rays at altitudes between 200 and 1000 km at the time of solar activity minimum is made. The altitude-dependence of charged particles discriminated by the gate signal from the detector was obtained. If the charged particle is assumed to be an electron, its energy is estimated to be greater than several hundred keV. The photon flux was tentatively derived by a rough assumption of the character and detecting efficiency of the phoswich detector. Evidence for the incidence of several-hundred-keV electrons to the region of comparatively low altitude is presented. (IAA) (Meteorol. Geoastrophys. Abstr.)

38836 OBSERVATION OF PARTICLE FLUXES BY L-3 ROCKETS. Nakagawa, Shigeo. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1269-74(Sept. 1966). (In Japanese).

The intensity distribution of proton and electron fluxes up to nearly 100 km, using rocket-borne solid-state detectors is reported. The proton flux in the energy range from 20 to 60 MeV is very weak, and its altitude variation was not accurately measured. The average intensity obtained was 0.007 ± 0.0025 $(cm^2\ sec\ ster)^{-1}$. Above 470 keV, the electron flux increased with rocket height and seems to point to electron precipitation from the radiation belt. Discussion is included of the presence of deuterons, tritons, and α particles in the inner radiation belt; the relationship among the secondary particles emitted from the belt; and the low energy deuteron flux at the top of the atmosphere which was observed in the nuclear emulsion stack exposed to cosmic rays by the balloon. (IAA) (Meteorol. Geoastrophys. Abstr.)

38837 ORIGIN OF COSMIC RAYS. Ginzburg, V. L.; Syrovatskii, S. I. New York, Pergamon Press, Inc., 1965. 443p. $15.00.

Translation of Proiskhozhdenie Kosmicheskikh Luchei by H. S. H. Massey.

The book is intended for research workers and others with advanced knowledge in the fields of physics, radiophysics, and astrophysics. Topics covered include primary cosmic rays on the Earth, cosmic magnetic bremsstrahlung (synchrotron) radio emission and cosmic rays in the Universe, motion of cosmic rays in the interstellar medium, the origin of cosmic rays, and quantitative galactic theory of the origin of cosmic rays. (W.D.M.)

Direct Energy Conversion

Refer also to abstracts 38533, 38809, and 39052.

38838 (AD-664494) AN EXPERIMENTAL AND THEORETICAL STUDY OF THE NONEQUILIBRIUM PLASMA IN THERMIONIC DISCHARGES. Final Report, December 1, 1966-November 30, 1967. Curry, Ronald H.; Norcross, David W.; Stone, Philip M.; Nygaard, Kaare J. (Sperry Rand Research Center, Sudbury, Mass.). Jan. 1968. Contract Nonr-5154(00). 68p. (SRRC-CR-68-4). CFSTI.

Effective coefficients for ionization and radiative energy loss were computed for different values of electron temperature and density. These coefficients and the neutral density yield the rates for net ion production and radiative energy loss from all sources except the resonance lines. Energy loss from resonance lines and the ion production cost are considered separately. The following general conclusions can be drawn: (1) the area within 0.4 mm of the emitter is a source of ion-electron pairs, the rest of the plasma being a sink; (2) inelastic energy losses decrease monotonically from the emitter to the collector; and (3) these effects are relatively independent of cesium pressure, but are generally proportional to output density. Furthermore, the differential equations governing the transport of particles, momentum, and energy in the plasma between the electrodes of a thermionic converter were more completely formulated. Specific advances are the inclusion of more exact coefficients for electron transport and for ion production and radiative energy loss in the plasma volume. In diode experiments, the electron temperature was determined from measurement of the continuum emitted by radiative recombination to the 6P states of cesium, and the electron density was determined from Stark broadening of the fundamental series lines. Of particular interest is observation of forbidden lines. (auth) (USGRDR)

38839 (N-68-11353) A METHOD OF OBTAINING SOME EXACT (NONLINEAR) SOLUTIONS OF THE BOLTZMANN-VLASOV EQUATIONS. Seitz, Robert N. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Aug. 28, 1962. 76p. (NASA-TM-X-60607). CFSTI.

A method is described for obtaining the exact, nonlinear, steady-state solutions of the "collisionless" Boltzmann-Vlasov equations for cylindrical and spherical diodes. It is shown that, when the electron and ion distribution functions along the boundaries of such a diode are functions only of known constants of the motion, the distribution function at all interior points can be prescribed as a functional of the electromagnetic momenta and the electromagnetic potentials ϕ and A. If, in addition, all of the first integrals of the motion can be specified, as is the case when cylindrical or spherical symmetry is present, then it is shown that the Poisson equation may be reduced to quadratures. Finally,

the method is applied to the problem of ion beam neutralization and numerical results are given. Among the other applications of the integral-of-the-motion method developed herein is the solution of the long-standing problem of the potential distribution across a cylindrical thermionic diode with thermal effects rigorously taken into account. (auth) (STAR)

38840 (N-68-12252) SOLAR THERMOELECTRIC GENERATOR DESIGN AND PANEL DEVELOPMENT PROGRAM. Raag, V.; Berlin, R. E.; Gnau, L. H. (Radio Corp. of America, Lancaster, Pa.). Dec. 20, 1967. Contract NAS3-10600. 122p. (NASA-CR-72340; RCA-647-DR-1220). CFSTI.

A silicon-germanium solar thermoelectric generator has been designed for operation at a distance of 0.25 AU from the sun. The generator delivers 150 watts of electrical power at a nominal load voltage of 28 volts; produces 36.4 watts per square foot of generator area; and weighs 3.23 pounds per square foot. The design and analysis of both thermoelectric and mechanical performances of this generator are considered in detail. Engineering layout drawings of the generator and its components are also presented. (auth) (STAR)

38841 (N-68-12718) MEASUREMENTS ON XENON FILLED NUCLEAR IRRADIATED THERMIONIC DIODES. Forman, Ralph (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 11p. (NASA-TM-X-52377; CONF-671045-7). CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

The properties of xenon filled thermionic diodes, exposed to nuclear radiation in the core of a 5.0-MW nuclear reactor, have been measured. The experimental technique consists of measuring the current-voltage characteristics of a gas-filled tube at increasingly higher radiation levels. The generation of ion-electron pairs in the gas by nuclear radiation results in space charge neutralization effects. (auth) (STAR)

38842 (N-68-14585) PARAMETRIC ANALYSIS OF RADIOISOTOPE CASCADED THERMOELECTRIC GENERATORS. Ward, James T.; Ruch, Robert (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1968. 27p. (NASA-TM-X-1501). CFSTI.

The generator consisted of a high-temperature silicon-germanium first stage and a lower-temperature lead telluride second stage was placed concentrically around a cylindrical fuel block. Heat was rejected from the outer surface of the generator shell; in most cases, fins were required to augment the heat rejection. The Si-Ge hot-junction temperature range was 1089 to 1255°K. The PbTe hot-junction temperature was fixed at 811°K and the PbTe cold-junction temperature varied from 422° to 700°K. The fuel-block length-diameter ratio varied from 0.5 to 10.0. The fuel-block-volume power-density range was 0.5 to 10.0 watts per cm^3. The generator power output was fixed at 250 watts electric. The performance of cascaded generators is also compared with the performance of single-stage Si-Ge generators. The results indicate that the cascaded generator operating at a Si-Ge hot-junction temperature of 1089°K had a minimum specific weight of 220 lbs per kilowatt electric (kW_e) at an efficiency of nearly 7%. For a Si-Ge hot-junction temperature of 1255°K, the minimum specific weight was 170 lbs per kWe with an efficiency of over 8%. The single-stage Si-Ge generator with a hot-junction temperature of 1255°K had a minimum specific weight of 100 lbs per kWe at an efficiency slightly below 6%. (auth) (STAR)

38843 (N-68-12989) THE DEVELOPMENT OF THERMIONIC ISOTOPE SPACE POWER TECHNOLOGY. APPENDIX 1. Final Technical Report. (Radio Corp. of America, Lancaster, Pa. Direct Energy Conversion Dept.). 1967. Contract NASw-1254. 187p. (NASA-CR-91354). CFSTI.

A compilation of computer programs are presented which provide the following capabilities: (1) The IV (volt-ampere) curves, obtained in testing a thermionic converter, are analyzed and compared to one another and to curves obtained from other converters. (2) The optimum A/L ratio for heat dam construction over a range of currents and efficiencies is calculated and printed. (3) An actual IV curve is taken and used to calculate power losses in the system and the work function and efficiency of the converter. (4) The values of the pressures encountered in heat pipe operation are calculated and printed. (5) A table of values found in a heat pipe operating at given temperatures and conditions are calculated and printed. (6) The desired heat and proposed lead, heater and lead materials, temperature difference from end to end of the lead, and the current passing through the lead are used to calculate and print the A/L ratio, the current flow, and voltage drop. (7) The inside diameter of a pipe is calculated. Tabulations on the thermal properties of converter materials are included. (STAR)

38844 (N-68-14630) PARAMETRIC ANALYSIS OF RADIOISOTOPE-THERMOELECTRIC GENERATORS. Ward, James J.; Bifano, William J.; Blair, Larry S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1967. 22p. (NASA-TM-X-1453). CFSTI.

A parametric analysis of a radioisotope thermoelectric power generator is presented. A cylindrical heat-source geometry was assumed with either lead telluride or silicon-germanium thermoelectric elements located around the lateral surface of the fuel block. The heat source was treated parametrically by using the effective-volume power density of the heat source as a variable. Generator efficiency and specific weight were determined for fuel-block length-to-diameter ratios from 0.5 to 10.0, effective-volume power densities from 0.5 to 10.0 watts per cubic centimeter (W/cc), thermoelectric element hot-junction temperatures of 811°K for lead telluride and 1089° and 1255°K for silicon-germanium, and generator electrical output powers from 100 to 1000 watts. The results indicate that a substantial specific weight advantage is gained by employing silicon-germanium thermoelectric elements rather than lead telluride. In all cases, however, minimum specific weight is achieved at the lowest output power level, that is, 100 watts electric (W_e). For silicon-germanium generators having an output power of 100 W_e, the minimum specific weights are 120 and 88 lb/kW_e (54.5 and 40 kg/kW_e) for hot-junction temperatures of 1089° and 1255°K, respectively, with corresponding generator efficiencies of 4.1 and 5.8%. (auth) (STAR)

38845 (N-68-17223) SPACE VEHICLE MISSILE POWER SUPPLIES. Annotated Bibliography. Benton, Mildred (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Nov. 1967. Contract DAAHO1-67-C-1036(Z). 226p. (NASA-TM-X-60877; RSIC-743). CFSTI.

This annotated bibliography contains 700 citations from open literature on power supplies. It is oriented toward batteries, fuel cells, thermionics, thermoelectrics, nuclear energy sources, and other new concepts of direct energy conversion which may be adaptable to space vehicles. (auth) (STAR)

38846 (N-68-19707) SOLAR THERMOELECTRIC GENERATOR DESIGN AND PANEL DEVELOPMENT PROGRAM. Fabrication Report. Gnau, L. H. (Radio Corp. of America, Harrison, N. J.). Mar. 20, 1968. Contract NAS3-10600. 65p. (NASA-CR-72386; RCA-647-FR-32068). CFSTI.

Three flat-plate sections of a developmental silicon-germanium solar thermoelectric generator, each with an area of 12.25 square inches, were fabricated in accordance with the Task II design for a 150-watt solar thermoelectric generator. The development effort required to achieve fabrication of the feasibility sections is described. The fabrication and assembly process specifications for the test sections are also considered in detail, supplemented by engineering layout drawings of the generator and its components. (auth) (STAR)

38847 THERMOELECTRIC GENERATOR. Campana, Robert J.; Melcher, Joseph C.; Merrill, Peter S.; Sargent, Walter S. (to United States Atomic Energy Commission). U. S. Patent 3,388,008. June 11, 1968.

This patent relates to an improved thermoelectric generator wherein electricity is generated upon subjecting opposite ends of a thermopile to different temperatures, featuring the provision of a thermal capacitance to one end of magnitude such that the product of thermal resistance and capacitance at that end approximates the product at the other end, thereby affording stable power output during rapid ambient temperature changes. (AEC)

38848 THERMIONIC ENERGY CONVERTER. Stahl, Kurt; Winkenbach, Herbert; Jester, Alfred; Langpape, Reinhard (to Brown, Boveri and Cie Aktiengesellschaft). U. S. Patent 3,382,154. May 7, 1968. Priority date July 3, 1964, Germany.

An emitter is described for thermionic energy conversion which includes an emitter body of electrically conducting material, nuclear fuel material in thermal contact with the emitter body, the ratio of the emitter surface (S) in cm^2 to the fuel quantity (Q) in cm^2 being not larger than $S/Q = 0.8E$, wherein E denotes the enrichment of the fuel material in percent. (auth)

38849 METHOD FOR OVER-OXYGENATING THE AIR SUPPLIED TO A MAGNETOHYDRODYNAMIC BLAST. (to Electricite de France Service National). British Patent 1,119,321. July 10, 1968. Priority date Feb. 10, 1966, France.

A process is described whereby the air supplied to an MHD conversion plant is enriched with oxygen by the decomposition at elevated temperature of an oxide of a polyvalent metal. The resulting lower oxide of this metal is re-oxidized at a lower temperature by the oxygen from the surrounding air, so that it can

be used for another oxidation cycle. Since the reaction in which the oxides are decomposed is endothermic, the heat required is supplied according to the invention by the gases issuing from the blowpipe of the plant. The first embodiment of the process necessitates the presence of at least two oxidation circuits operating in alternation. In another embodiment of the process, the feed air is enriched in a continuous cycle. (M.H.R.)

38850 PLASMA STABILITY AND VOLTAGE OSCILLATION IN AN MHD GENERATOR. Ganefel'd, R. V.; Strashinin, E. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 33-6(1967). (In Russian).

The stability of an isothermal equilibrium plasma in an MHD generator is discussed relative to the propagation of potential and nonpotential perturbations in the plasma. The plasma consists of a neutral component and some seed material added to it which is in equilibrium with the neutral component. It is assumed that density perturbations take place in a plane perpendicular to the external magnetic field. A dispersion relation is obtained for plane acoustic and electromagnetic waves propagating in the plasma, one set of waves propagating along or against the current j_0 and another set, propagating along or against the plasma flow. Conditions are discussed which lead to amplification of these waves with a maximum increment given by an equation. The frequency of the MHD generator voltage modulation is calculated and found to be in good agreement with experimental observations. (ATD)

38851 EFFECT OF PARTITION PLACEMENT ON MHD-CHANNEL CHARACTERISTICS. Lavrent'ev, I. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 89-95(1967). (In Russian).

The effect of placing a pair of nonconducting partitions on the integral characteristics of a plane MHD generator is investigated. It is assumed that the channel has two ideally conducting electrodes and in it are placed two nonconducting semi-infinite partitions. For small magnetic Reynolds numbers, the governing two-dimensional current and electric potential equations are solved for this geometry, using conformal mapping on the half-section. The expression for the power output is then given. A numerical solution is obtained for the case where the magnetic field B is constant on the electrode and is zero outside the electrode zone. For this case, it is shown that the power output is optimal if the partitions are placed inside the electrode zone. (TSS) (ATD)

38852 VOLT-AMPERE CHARACTERISTICS OF A-C ARC BURNING IN A VORTEX TYPE PLASMATRON. Bogatyreva, V. A.; Vorob'eva, N. I.; Zhukov, M. F.; Sukhinin, Yu. I. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 13, Ser. Tekh. Nauk, No. 3, 159-62 (Oct. 1967). (In Russian).

Volt-ampere characteristics of a continuously burning arc in a plasmatron with air-vortex stabilization are described. The characteristics are presented in the form of criteria. Formulas are developed for high-power plasmatrons. (R.V.J.)

Fluid Physics

Refer also to abstract 38261.

38853 (CONF-680438) NINTH SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, UNIVERSITY OF TENNESSEE SPACE INSTITUTE, TULLAHOMA, TENN., APRIL 3-5, 1968. (Tennessee Univ., Tullahoma. Space Inst.). 174p.

Forty-eight papers are included. The longer papers generally describe completed work, and their full texts are given. The shorter presentations deal primarily with work in progress and are represented only by their abstracts. The papers are grouped under the following headings: engineering facilities and components, accelerators, magnetofluidynamics, plasma properties, open-cycle generators, and closed-cycle generators. (M.H.R.)

38854 (N-68-14078) MAGNETOHYDRODYNAMIC FLOWS OVER A ROTATING DISK. Pao, Hsien-ping (Catholic Univ. of America, Washington, D. C.). Jan. 1968. 25p. (NASA-CR-989). CFSTI.

The flow of an incompressible viscous electrically conducting fluid over a rotating disk is investigated. In addition, a circular magnetic field is also imposed at the disk. One physical interest in this flow lies in the possibility of using such a magnetic field to shield a rotating body from excessive heating. Similarity assumptions lead to a reduction of the governing equations to a set of ordinary differential equations. These are integrated numerically. Some approximate solutions are also obtained. The role of the magnetic field here is to thicken the flow boundary layer and to reduce the strength of the axial flow field. That means, the magnetic field has a diffusing and stiffening effect upon the flow field. As a consequence, the frictional moment at the disk is reduced. For sufficiently large values of the applied magnetic field, the boundary layer separates from the surface of the disk. (auth) (STAR)

38855 (N-68-14472) EXPERIMENTAL STUDIES IN MAGNETOFLUIDDYNAMICS: PIPE FLOW THROUGH A SOLENOID OF FINITE LENGTH. Maxworthy, T. (Jet Propulsion Lab., Pasadena, Calif.). Dec. 15, 1967. Contract NAS7-100. 24p. (NASA-CR-91773; JPL-TR-32-1198). CFSTI.

A liquid sodium tunnel was designed and built to study aligned-field magnetofluiddynamic (MFD) flows. Its major features and the nature of the flow in the test section are described. In particular, it is found that an exit disturbance, created as the liquid conductors leaves the region of magnetic field, can propagate into the test section and affect the flow there. However, only under the most adverse conditions, i.e., very high magnetic fields and low flow velocities, does this impair the usefulness of the tunnel as a device for the accurate measurement of MFD flows. (auth) (STAR)

38856 (N-68-19005) GROWTH AND DECAY OF MAGNETIC FIELDS IN TURBULENT FLUIDS. Cocke, John J. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). Mar. 1968. 29p. (NASA-TM-X-60924). CFSTI.

The magnetohydrodynamic properties of random, stationary turbulence are studied. If the fluid is highly conducting and the magnetic field weak, the logarithm of the field strength is shown to be a random-walk variable to which the central limit theorem applies. The behavior of infinitesimal material displacements which move frozen in the fluid, and which are, on the average, stretched by the turbulence is investigated. Plausible extension to high ohmic dissipation is made, and it is concluded that in the absence of a large-scale Fourier component, the ohmic loss destroys the field. An experiment is proposed to test these conclusions. (auth) (STAR)

38857 UNSTEADY COUETTE FLOW OF A CONDUCTING FLUID BETWEEN TWO PARALLEL PLATES UNDER A TRANSVERSE MAGNETIC FIELD. I. Vidyanidhi, V. (Andhra Univ., Waltair, India). Proc. Indian Acad. Sci., Sect. A, 67: 199-207 (Apr. 1968).

The unsteady Couette flow of a viscous incompressible fluid between two parallel plates in the presence of a transverse magnetic field is considered. Using the Laplace transform technique, expressions for the velocity of the fluid and the intensities of the electrical and magnetic fields are obtained in two cases: when the plates are nonconducting and when they are perfectly conducting. (auth)

38858 MAGNETOHYDRODYNAMIC FLOWS OVER A ROTATING DISK. Pao, H. P. (Catholic Univ. of America, Washington, D. C.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1285-91 (July 1968).

The flow of an incompressible, viscous, electrically conducting fluid over a rotating disk is investigated. .n addition, a circular magnetic field is also imposed at the disk. One physical interest in this flow lies in the possibility of using such a magnetic field to shield a rotating body from excessive heating. Similarity assumptions lead to a reduction of the governing equations to a set of ordinary differential equations. These are integrated numerically. Some approximate solutions are also obtained. The role of the magnetic field here is to thicken the flow boundary layer and to reduce the strength of the axial flowfield, i.e., the magnetic field has a diffusing and stiffening effect upon the flowfield. As a consequence, the frictional moment at the disk is reduced. For sufficiently large values of the applied magnetic field, the boundary layer separates from the surface of the disk. (auth)

38859 KARMAN-POHLHAUSEN METHOD FOR MHD BOUNDARY LAYERS. Ramamoorthy, P. (Langley Research Center, Hampton, Va.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1407-9(July 1968).

Heiser and Bornhost obtained a fourth-degree polynomial profile for the velocity in the boundary-layer of a weakly conducting incompressible fluid flowing past a semi-infinite flat plate in the presence of a magnetic field. This profile is used in the Kármán-Pohlhausen method to solve the problems that were treated by different methods. The profile satisfies the condition on the third derivative at the plate instead of the usual condition of second derivative vanishing at the edge of the boundary layer. This takes into account the influence of the electromagnetic forces within the boundary layer. (TSS)

38860 MAGNETOHYDRODYNAMIC FLOW IN A CIRCULAR CHANNEL WITH MAGNETIC REYNOLDS NUMBER TAKEN INTO CONSIDERATION. Bertinov, A. I.; But, D. A.; Kalugin, V. N.

Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 96-103(1967). (In Russian).

The one-dimensional incompressible flow of an electrically conducting fluid is analyzed in a circular channel of thickness δ and length L under an unsteady, radial magnetic field $B_e(t)$. The flow is assumed incompressible, $\delta \ll L$, $\delta \ll r_0$ (r_0 is channel radius), and the magnetic Reynolds number $R_m \geq 1$. The solution of induction equation is obtained by using an electric circuit analogue, and B_e is represented by a harmonic function. Two cases are considered in detail. Case I corresponds to a low frequency field and large conductivity σ, with velocity v. The resulting magnetic induction and current density expressions are given. Case II corresponds to moderate frequencies and large velocity and conductivity. In both cases, increasing R_m causes a weakening in the magnetic field outside the channel and a strengthening in the field inside the channel. Increasing $\partial B/\partial t$ causes a weakening of the field in the channel mid-section. (ATD)

38861 EXPERIMENTAL STUDY OF VELOCITY DISTRIBUTION IN A TURBULENT MERCURY FLOW IN THE CHANNEL OF A PLANE INDUCTION PUMP. Valuev, Yu. A.; Vasil'ev, S. V.; Okhremenko, N. M.; Smirnova, L. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 104-10(1967). (In Russian).

The turbulent velocity profiles in the metallic channel of a plane, linear induction pump are studied in detail. An alternating magnetic field is generated by a 50-Hz alternating current in mercury. The induction pump has contact poles along its walls, and the mean velocities attained in the channel are 1.05 and 2.1 m/sec. In the presence of the magnetic field, the velocity profiles are found to be fuller, with steeper gradients near the wall, than with zero magnetic field. The filling of the profiles is found to be in direct proportion to the increase in the modified Stuart number, given by $St = Ha^2 s/Re(1 - s)$, where Ha is the Hartmann number, Re the Reynolds number, and s the mean slip. Along the width of the channel the velocity profiles show M-shaped forms caused by pronounced asymmetries in the magnetic field. Graphic isotachs are obtained to show the magnitudes of these flow and field asymmetries, which are found to be similar to one another. Under reduced flow conditions, negative values were obtained for the local flow velocity, caused by mixing in the liquid metal flow. (ATD)

38862 UNSTEADY SUBSONIC FLOW OF CONDUCTING GAS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kazachkov, Yu. A.; Korotkov, B. A.; Shipulin, I. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 29-32(1967). (In Russian).

The one-dimensional unsteady flow of a conducting gas is analyzed in crossed electric and magnetic fields. In the analysis, the viscous effects are represented by the friction force $F = \xi\rho u^2/2D$, where D is the hydraulic radius and ξ the friction factor, and the heat conduction losses are assumed known. The solution of the governing equations is obtained by introducing three families of characteristics. These are then written in finite difference form and solved for the gas velocity, pressure, and temperature at the channel entrance, at an internal point and at the channel end. The velocity versus time curve at the channel entrance shows shock-like behavior as the electric field is changed suddenly from 2380 V to zero and back. (ATD)

38863 LIFT ON A THIN PLATE OF INFINITE SPAN IN MAGNETOGASDYNAMICS. Dzhuzumkulov, T. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 37-9(1967). (In Russian).

The problem of determining the lift of a thin plate of infinite span at a small angle of attack in a supersonic flow of an ideally conductive medium subjected to a magnetic field normal to the direction of flow is considered. This problem is equivalent to the problem of the steady motion of a piston and includes a term corresponding to the additional pressure due to the magnetic field in the expression for total pressure. Pressure behind the shock wave and in the low-pressure region is determined. Expressions for pressure coefficients on the upper and lower surfaces of the plate are established, and a formula for the lift coefficient is derived. It is shown that in the case of a thin plate moving in an ideally conductive gas at a small angle of attack the lift coefficient increases faster than in the case of ordinary gas dynamics. (ATD)

38864 REFLECTION OF RAREFACTION WAVES IN MAGNETOGASDYNAMICS. Dzhuzumkulov, T. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 40-2(1967). (In Russian).

The reflection of rarefaction waves in magnetogasdynamics is analyzed using the second family of characteristics equations. The characteristics equation and the conditions on the characteristics are given. For the adiabatic constant $\gamma = 2$, a simple expression is obtained for the second family of characteristics. An expression is also derived for the impulse on the wall which is found to be different from its corresponding gas dynamics counterpart. (ATD)

38865 FINITE DIFFERENCE FORMULATION OF THE PROBLEM FOR CURRENT AND POTENTIAL DISTRIBUTION IN A PLANE MHD CHANNEL. Ustimenko, L. Yu. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 49-55(1967). (In Russian).

A finite difference formulation is given to calculate the current and potential distributions in a plane MHD channel. The analysis considers segmented electrodes, Hall currents, and variable conductivity along the channel length. The flow is assumed to be one-dimensional with an applied transverse magnetic field. The flow field is divided into rectangular meshes and the integral $\int j_y dy$ is written in finite difference form for each mesh. Matching conditions are then constructed on the mesh boundaries, and a set of algebraic equations is obtained for the current field and the potential distribution. (ATD)

38866 MAGNETOHYDRODYNAMIC ANALYSIS OF THREE-DIMENSIONAL MOTION NEAR THE STAGNATION POINT. Karyakin, Yu. E. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 56-9 (1967). (In Russian).

A similarity solution is given for the stagnation flow of a conducting incompressible flow in three dimensions in the presence of a transverse magnetic field. Induced effects are neglected, and the following transformation is used to change the partial differential equations to ordinary differential equations. The resulting equations are solved numerically, and results for the skin friction in both the x and z directions are shown graphically. In the presence of a transverse magnetic field a distinct reduction is obtained in the skin friction. (ATD)

38867 STABILITY OF A PLANE MAGNETOHYDRODYNAMIC FLUID JET. Eliseev, B. V.; Lobanov, A. D. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 66-71(1967). (In Russian).

The stability of a plane MHD jet is analyzed, with the case of zero magnetic field considered first. The flow is assumed to be incompressible and unsteady, with perturbations imposed on the fluid. Symmetric and antisymmetric solutions are obtained for the governing perturbation equations, and the dispersion equation is obtained for the symmetric case. A similar equation is obtained for the antisymmetric case. The analysis is then extended to the case of crossed electric and magnetic fields. The linearized MHD perturbation equations are solved in an analogous manner, and it is found that the magnetic field has a stabilizing effect on the jet, with its length increasing as the $\frac{2}{3}$-power of the applied magnetic field for the antisymmetric oscillations and the square of the magnetic field for symmetric oscillations. (ATD)

38868 PLANE SUBMERGED TURBULENT JET OF INCOMPRESSIBLE CONDUCTING FLUID IN MAGNETOHYDRODYNAMICS. Pleshanov, A. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 72-5(1967). (In Russian).

A self-similar solution is obtained to the plane incompressible flow equations of a turbulent jet in the presence of a transverse magnetic field. For small magnetic Reynolds numbers, the boundary conditions on the jet are developed. (TSS) (ATD)

38869 ON A PROBLEM IN THE THREE-DIMENSIONAL BOUNDARY LAYER IN MAGNETOHYDRODYNAMICS. Shcherbinin, E. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 76-9(1967). (In Russian).

The problem of the viscous conducting flow interaction between a two-dimensional laminar jet and a boundary layer over a semi-infinite flat plate is studied. A schematic is given of the flow where the magnetic field is directed along the y axis and induced effects are neglected. The governing equations are linearized and solved iteratively. Expressions are obtained for the velocity distribution u in the first and second approximations. The hydrodynamic solution is obtained. (TSS) (ATD)

38870 DRAG OF MAGNETOHYDRODYNAMIC PIPES. Branover, G. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 3-16 (1967). (In Russian).

Problems of calculating the drag coefficients of rectangular and circular pipes for laminar and turbulent flow are considered, for $Re \leq 4.10^5$. Theoretical analysis and experiment show that in flow in a transverse magnetic field, pipe roughness affects drag even in laminar flow. The effective height of the roughness is a function of field strength, so that the longitudinal pressure gradient is a nonlinear function of flow velocity in laminar flow. In flow in rough pipes, transition from laminar to turbulent flow cannot be determined experimentally from the drag coefficient. The results discussed pertain to pipes with nonconducting walls, hydraulically smooth and rough walls, and walls with high electric conductivity. From the point of view of suppressing turbulence, a transverse field in a rectangular pipe at small β has considerably more effect than a longitudinal field on axisymmetric or plane-parallel flow. (ATD)

Geophysics

Refer also to abstracts 38699, 38700, and 38807.

38871 (AD-664577) A PROPAGATION EXPERIMENT FOR MEASURING ELECTRON DENSITY IN THE D-REGION OF THE IONOSPHERE. Westlund, Clay D.; Littlefield, Craig (Utah Univ., Salt Lake City. Upper Air Research Lab.). Sept. 1967. Contract AF19(628)-5044. 54p. (UU-67-7; AFCRL-67-0536). CFSTI.

Determination of the profile of electron density versus altitude for the D-region of the ionosphere is made difficult because of the large ratio of neutral particles to charged particles. Experimental techniques which have been useful in the higher regions have not proven suitable for use in the D-region. This report describes a propagation experiment which can provide measurements related to electron density versus altitude. The experiment requires that two, harmonically related frequencies be transmitted from a rocket as the rocket travels through the D-region. Each signal is separated into ordinary and extraordinary waves by the gyrotropic medium, and each of the components is influenced differently as it propagates through the medium. When the signals are received on the ground, the various modes are identical and measurements are made of relative Doppler shift and of relative absorption which occurred in transit. The theory of the experiment is briefly outlined and the experimental system is described. (auth) (USGRDR)

38872 (AD-668092) ELECTRIC FIELD IN THE IONOSPHERE: A THEORY OF ITS ORIGIN AND EFFECT. Environmental Research Papers No. 282. Sen, Hari K. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Mar. 1968. 20p. (AFCRL-68-0134; CONF-680521-1). CFSTI.

From 4th International Conference of the Universal Aspects of Atmospheric Electricity, Tokyo, Japan.

The anomalously high electron temperature in the lower ionosphere (E region) cannot be attributed to photoelectrons (Spencer and Brace, 1965). In this report, it is shown that electric fields due to charge separation in the dynamo region provide adequate energy for this purpose. Application of the formula for the velocity distribution of the electrons in crossed electric and magnetic fields (Sen and Wyller, 1960) to the observational data gives electric fields perpendicular to the magnetic field of intensity about 20 to 40 V/km. This is an order of magnitude higher than that obtained in the current dynamo theory. A theory of the origin of the electric field in charge separation due to neutral wind drag is given. The theory leads to the right order of magnitude estimate of the dimensions of ionospheric irregularities. Another likely source for the electric field is where the solar wind meets the magnetosphere (magnetopause). It is shown that a field ~1 V/m can build up in the magnetospheric plasma sheath, as in a discharge tube and be conducted down into the ionosphere along the lines of magnetic force. It is further shown that an electric field of this magnitude can cause the requisite auroral particle acceleration and sheath current for the main phase of magnetic storms. (auth) (USGRDR)

38873 (AD-668202) AURORAL INPUT-OUTPUT EXPERIMENT. Final Report, April 1, 1961-January 31, 1968. Evans, John E.; Johnson, Richard G.; Meyerott, Roland E. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Jan. 31, 1968. Contract Nonr-3398(00). 310p. (LMSC-8-79-68-1). CFSTI.

A study of the use of natural phenomena to simulate radio and radar blackout effects led to the development of the auroral input-output experiment. The objective was to fully document several pertinent parameters in a volume of the upper atmosphere being bombarded by fast particles. Incoming energetic particles (the input producing the auroras were measured by an instrumented polar orbiting satellite. The optical emissions and integrated electron content (the outputs) were measured simultaneously and with good geometry by photometers and radio receiving equipment (for receiving signals from the satellite borne radio beacon) on instrumented aircraft and/or ground stations. Low-energy (20 eV to 100 keV) electron and proton detectors, photometers, beacons, and fast data-handling equipment were developed for seven satellite packages, four of which have provided extensive data on particle fluxes, angular distributions, energy spectra, and precipitation patterns and on 3914-A and vacuum uv emissions. A 5-channel filter scanning photometer (1 scan/sec) and a 3-frequency (20, 40, and 120 MHz) phase-locked coherent receiver for signal strength and differential Doppler electron content measurements, plus auxiliary optical and tape recording gear, were adapted to aircraft use and were operated underneath the satellite transits over the auroral zone in Alaska. (auth) (USGRDR)

38874 (AD-668436) MILLSTONE HILL THOMSON SCATTER RESULTS FOR 1964. Evans, John V. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Nov. 15, 1967. Contract AF19(628)-5167. 53p. (TR-430; ESD-TR-67-563). CFSTI.

Thomson scatter (incoherent backscatter) observations of the ionosphere were made at Millstone Hill at a wavelength of 68 cm during 1964, for 30-hour periods every two weeks. These data have been employed to derive the mean hourly F-region (200 to 700 km) electron density profile and electron and ion temperature curves in each month. The results are presented in this report, together with the derived seasonal variation of electron density (at 0600, 1200, 1800, and 2400 hours local time) and the average daytime (0900 to 1500) and nighttime (2100 to 0300) electron and ion temperature behavior. Separate measurements with a 23-cm radar permitted the temperature results reported to be extended to lower altitudes (130 km) and, in addition, provided information concerning the ionic constituents between 130 and 230 km. (auth) (USGRDR)

38875 (LA-3944) SCATTERING OF GAMMA RAYS IN AN EXPONENTIAL ATMOSPHERE. Cashwell, E. D.; Longmire, Conrad; Neergaard, J. R. (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 39p. Dep. CFSTI.

In studying the electromagnetic signal from the explosion of a nuclear device at high altitudes, a problem of importance is the determination of the time dependence of a gamma-ray pulse as it undergoes Compton scattering in the earth's atmosphere. This report gives the results of Monte Carlo calculations designed to study this problem. (auth)

38876 (N-68-11247) COMPRESSION OF THE PLASMASPHERE DURING GEOMAGNETICALLY DISTURBED PERIODS. Taylor, H. A. Jr.; Brinton, H. C.; Pharo III, M. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1967. 31p. (NASA-TM-X-63033; X-621-67-559). CFSTI.

Evidence of the behavior of the plasmasphere during the important solar flare events of July 7, 1966 and July 9, 1966 is presented and results are compared to both earlier storm time data obtained from OGO's I and III, and related whistler observations of the plasmapause. Positive ion spectrometer results from OGO III during June to July 1966 provided profiles of H^+ and He^+ to altitudes as great as 40,000 kilometers in the magnetosphere, where L = 8. Results indicated that (1) within the plasmasphere the H^+ profiles fall off rather smoothly with altitude and L, from concentrations of the order of 10^4 ions/cm^3 near L = 2; (2) at the outer edge of the plasmasphere, the H^+ concentrations decrease very rapidly to concentrations of 5×10^2 ions/cm^3 or less; and (3) the He^+ profiles closely parallel the H^+ profiles at a concentration typically lower by a factor of nearly 100. The location of the plasmapause crossings observed near midnight local time was found to vary with magnetic activity, with an inverse correlation between the L coordinate of the plasmapause and the maximum value of K_p in the 24 hours preceding the event. These results, compared with whistler measurements of the plasmapause, indicate large scale expansion and contraction of the plasmasphere relative to specific magnetic storms. Associated with solar flare events occurring on July 7 to 9, 1966 and June 15, 1955, the plasmasphere was observed to be displaced inward to L positions as low as L = 3.3, following $K_p \geq 5$, in contrast to quiet magnetic conditions when the plasmasphere expands to L = 6 or higher. (STAR)

38877 (N-68-11254) INVESTIGATION OF MAGNETOSPHERIC PHYSICS. Technical Status Report, Period Ending March 31, 1967. Kennel, C. F.; Petschek, H. E. (Avco-Everett Research Lab., Everett, Mass.). Contract NASw-1400. 19p. (NASA-CR-90221). CFSTI.

A theory of the coupling of the neutral sheet plasma flow to particle precipitation to form the nightside auroral zone can be constructed using only the most generalized properties of plasma turbulence. Several features, the pitch-angle isotropy of the auroral precipitation, the location of separate precipitation maxima for ions and electrons, and the acceleration of high-energy particles, are described by this model. The properties of the specific mode of plasma turbulence are still somewhat unclear, since the auroral zone plasma has a large ratio of plasma to magnetic pressure, a case not extensively studied thus far in the fusion literature. (auth) (STAR)

38878 (N-68-11589) ROCKET MEASUREMENTS OF THE E-REGION ELECTRON DENSITY DISTRIBUTION IN THE VICINITY OF THE GEOMAGNETIC EQUATOR. Aikin, A. C.; Blumle, L. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1967. 24p. (NASA-TM-X-55973; X-615-67-498). CFSTI.

Six Nike–Apache rockets were instrumented and launched in March 1965 to obtain electron density profiles of the E region in the vicinity of the geomagnetic equator near the coast of Peru. Four of the flights, which occurred around local noon, exhibited little variation; and no sporadic E layer was observed, although a q-type sporadic E was visible on the ionograms taken simultaneously with the flights. The two flights conducted at night showed extreme variability at 150 km, with values of 2×10^3 cm^{-3} and 4×10^4 cm^{-3} obtained at 200 km for the two flights. In order to explain this difference, it is suggested that either on certain nights or after midnight the E region above 150 km is under F-region control. A downward drift was also found at night. Analysis of the electron saturation current of the Langmuir probe included as part of the rocket payload resulted in a saturation current to electron density ratio of 10^{-10} amp/cm^3, although significant altitude variations are found. (STAR)

38879 (N-68-11591) THE SCALAR MAGNETIC INTENSITY AT 1100 KILOMETERS IN MIDDLE AND LOW LATITUDES. Zmuda, A. J.; Radford, W. E.; Heuring, F. T.; Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Sept. 1967. Contract NOw-62-0604-c. 28p. (NASA-CR-90522). CFSTI.

With a Varian Rb-85 magnetometer, satellite 1964 83C measured the scalar magnetic intensity in middle and low latitudes at about 1100 km. The differences between observed and computed values show quasi-sinusoidal spatial variations indicative of errors in the harmonic coefficients with $n \approx 3$, $m \approx 4$, and $m \approx 6$. The isodynamic lines in the South Atlantic anomaly form closed loops around a center at 20°S and 45°W. In the recovery phase of the storm of 1312 UT April 17, 1965, a decrease in intensity occurs which is comparable to the decrease at the Earth's surface. (auth) (STAR)

38880 (N-68-11613) THE DEVELOPMENT OF THE FORBUSH DECREASE AND THE GEOMAGNETIC STORM FIELDS. Yoshida, S.; Akasofu, S.-I. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Dec. 1965. 23p. (NASA-CR-90497). CFSTI.

Relationships between the development of Forbush decreases and characteristics of associated geomagnetic storm fields are examined. It is shown that the onset of a significant Forbush decrease is more closely related to the development of successive sudden impulses of worldwide geomagnetic micropulsations during geomagnetic storms than to a simple step function-like storm sudden commencement. The magnitude of the main phase decrease shows no obvious relation with the magnitude of the Forbush decrease. (auth) (STAR)

38881 (N-68-11628) INTERACTION OF THE MAGNETIZED SOLAR WIND WITH THE MOON. Whang, Y. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1967. 29p. (NASA-TM-X-63046; X-612-67-580). CFSTI.

In July 1967 the Explorer 35 spacecraft was launched into a lunar orbit to study the interaction of the magnetized solar wind plasma with the Moon. The experimental results indicate that a detached bow shock wave does not exist in the vicinity of the Moon. Thus the flow conditions near the Moon do not resemble those near the Earth's magnetosphere. In this paper the solar wind flow around the Moon is treated theoretically as a free molecule flow of magnetized plasma. Analytical results are obtained to describe the distribution of the ion density and the ion flux in the vicinity of the Moon. A sizable empty cavity is produced in the near-downstream vicinity of the Moon; across the boundary of the cavity the plasma flow changes rapidly from the undisturbed condition to the void condition. The disturbed region in the downstream forms a long wake on the dark side of the Moon. The direction of the wake is deflected slightly toward the field lines. The thickness of the wake, measured perpendicular to the plane of the solar wind velocity and the interplanetary magnetic field, is constant at one lunar diameter. On the other hand, the width of the wake, measured parallel to that plane, increases with distance from the Moon. The length of the wake is of the order of 100 lunar radii. (auth) (STAR)

38882 (N-68-11860) EVALUATION OF GEOMAGNETIC HARMONIC SERIES FOR 1100 KILOMETERS ALTITUDE. Heuring, F. T.; Zmuda, A. J.; Radford, W. E.; Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Sept. 1967. Contract NOw-62-0604-C. 19p. (NASA-CR-9054). CFSTI.

Magnetic intensities obtained with satellite 1964-83C are used to evaluate six harmonic sets being considered in relation to an International Geomagnetic Reference Field. As the number of terms in each series increases, the rms difference between observed and computed values decreases first rapidly and then slowly but ultimately reaches a plateau value. The GSFC 12/66 field of Cain et al., gives the best fit to the observations with the rms residual ultimately equalling 67 γ for geomagnetic intensities in the range 15,000 to 31,000 γ. (auth) (STAR)

38883 (N-68-13371) THE PLASMAPAUSE AND ITS RELATION TO THE ION COMPOSITION IN THE TOPSIDE IONOSPHERE. Mayr, H. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1967. 22p. (NASA-TM-X-63063; X-621-67-570). CFSTI.

The high $O^+ - H^+$ transition level at latitudes above 50° and the plasmapause with its characteristic density plateau suggest that both features are strongly correlated; upward fluxes of protons can consistently account for both observations. It is shown that plasma escape can produce sufficiently large fluxes at latitudes where the field lines are open, thus significantly decreasing the hydrogen-ion density. As a result, plasma diffusion across field lines is induced-coupled with upward fluxes of ionization along field lines, which leads to the formation of a density plateau that characterizes the transition region from the open to the closed magnetosphere. Collision-type perpendicular diffusion would produce an enormously rapid transition over a distance of a few meters, which is not observed. This suggests that a turbulent state is built up in the transition region; thus, Bohm's coefficient for turbulent diffusion is employed, and this leads to a quantitatively satisfying description of the plasmapause. (auth) (STAR)

38884 (N-68-14025) RESONANCES IN THE DRIVING-POINT IMPEDANCE OF AN ELECTRIC DIPOLE IN THE IONOSPHERE. Blair, W. E. (Stanford Research Inst., Menlo Park, Calif.). Mar. 1967. Contract NAS5-9309. 33p. (NASA-CR-91620; TR-1). CFSTI.

For Stanford Univ., Calif.

The resonances in the driving-point impedance of a center-fed cylindrical electric dipole imbedded in the ionosphere are analyzed. The ionospheric model is a lossy, anisotropic, homogeneous neutral plasma containing various ionic constituents. It is found that there are zeros in the reactance at the upper and lower hybrid frequencies and poles at the electron and ion gyrofrequencies. These critical frequencies are independent of antenna length and orientation (parallel or perpendicular to the earth's magnetic field) to the first-order approximation. It is shown that pole-zero frequencies could be used to determine the earth's magnetic field strength, electron density, and ion masses and densities at any point in the ionosphere at which the impedance was measured. (auth) (STAR)

38885 (N-68-17331) TIME-OF-FLIGHT MASS SPECTROMETER SUITABLE FOR IONOSPHERIC COMPOSITION INVESTIGATIONS. Diem, H. T. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Sept. 25, 1967. 64p. (NASA-CR-93184; SR-309). CFSTI.

A small sensitive time-of-flight mass spectrometer is being developed which appears to fulfill the necessary requirements for an ionospheric probe. The instrument's small size and light weight along with its high sensitivity and ability to operate at relatively high pressures make it a desirable tool for investigating the ion composition of the D and E regions of the ionosphere. Preliminary results are discussed. (auth) (STAR)

38886 (N-68-17332) POLARIZATION MEASUREMENTS OF THE FAR ULTRAVIOLET DAY AIRGLOW. Heath, Donald F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1968. 23p. (NASA-TM-X-63108; X-622-68-31). CFSTI.

The intensity and polarization of the O I 1304 Å and 1355 Å multiplets and the Vegard–Kaplan System of N_2 were measured in the dayglow up to 200 km at 90° to the incident solar radiation. No polarization was observed. The lack of observed polarization of O I, 1355 Å and the N_2, Vegard–Kaplan system is proof of collisional excitation. Comparison of the observed intensities of O I, 1355 Å and the N_2, VK system with recent theoretical predictions for photoelectron excitation show excellent agreement for O I but the N_2, VK emission is 10 times weaker than predicted. The volume emission rate of N_2, VK is observed to follow the N_2 density above 165 km. (auth) (STAR)

38887 (N-68-17614) MEASUREMENT OF ELECTRIC FIELDS IN THE IONOSPHERE. Final Report. Levy, Gerald; Jacobs, Herbert; Bendor, Edgar (Fairchild Hiller Corp., Farmingdale, N. Y. Republic Aviation Div.). Jan. 1968. Contract NAS8-20663. 126p. (NASA-CR-61189). CFSTI.

This report describes the development of an experimental laboratory model of an electric field meter using the electron beam deflection techniques and the system considerations for its use.

This meter is designed to operate in the vicinity of a spacecraft within the ionosphere. The use of a weak electron beam (less than 1 microampere) provides a field-sensing element which does not disturb the environment or the field it is measuring, while still permitting the association of the measured fields with the orbiting spacecraft at desired locations on, near, or far from its surface. The meter has a dynamic range from 10 mV/meter to 1000 V/meter with an accuracy of ±1 mV/meter at 10 mV/meter and ±1% above 100 mV/meter. (auth) (STAR)

38888 (N-68-18047) RELATIONSHIP BETWEEN TYPE Pc1 OSCILLATIONS AND MAGNETIC STORMS. Piyasova-Bakunina, A. T.; Matveeva, E. T. Translated for Volt Technical Corp., Washington, D. C., from Geomagn. Aeron., 8: No. 1, 189-91(1968). 3p. (NASA-CR-93243; ST-GM-10-686). CFSTI.

The relationship between type-Pc1 oscillations and magnetic storms are discussed in the light of the character of the former and by investigating their full spectrum of frequencies of appearance, namely the tendency to a shift of the time of pearl appearance in the course of 24-hour storm days. (auth) (STAR)

38889 (N-68-18175) TAKING INTO ACCOUNT THE VERTICAL DRIFT OF MOLECULAR IONS WHEN DETERMINING THE KINETIC PARAMETERS OF IONIZATION-RECOMBINATION PROCESSES IN THE F_2-LAYER MAXIMUM. Klimov, N. N.; Solov'ev, Yu. F. Translated for Volt Technical Corp., Washington, D. C., from Geomagn. Aeron., 8: No. 1, 177-8(1968). 3p. (NASA-CR-93284; ST-AI-10679). CFSTI.

The kinetic parameters during the years of high solar activity were determined by assuming that only molecular ions are moving. The calculation was conducted in the assumption that near the main electron concentration maximum the molecular ions have a scale height equal to that of the neutral gas. Thus, the vertical drift of molecular ions due to neutral gas can be disregarded by taking into account the height distribution of the molecular ions. (STAR)

38890 (N-68-18824) ANALYSIS OF POLAR CAP ABSORPTION EVENTS. 3. TIME RELATION OF RF-H α MAXIMUM INTENSITY FOR ALL CM BURSTS $\leq 500 \times 10^{-22}$ W$(M^2C/S)^{-1}$. Quarterly Report. Jonah, Fred C. (LTV Aerospace Corp., Dallas, Tex. LTV Astronautics Div.). Oct. 12, 1966. Contract NAS9-4911. 35p. (NASA-CR-65996; QR-2). CFSTI.

In support of previously investigated polar cap absorption (PCA) events, the analysis was extended to all known cases where the peak flux at one or more of the selected frequencies in the decimeter and centimeter range from 1420 through 3750 Mc exceeded 500×10^{-22} W$(m^2c/s)^{-1}$ associated with flares of importance $\leq 2^+$. The time relation of flares, rf emissions and known PCA events are discussed, along with flares of major rf emissions not followed by a PCA event. It was found that for 78% of all the flares that were not followed by a known PCA event the time of the peak rf intensity coincided with or preceded the time of the H α flare maximum. Tabulated data are included on (1) radioemissions with peak flux $\geq 500 \times 10^{-22}$ W$(m^2c/s)^{-1}$, (2) number of major rf-Hα events followed and not followed by PCA, and (3) minor flares followed by a PCA event. (STAR)

38891 (N-68-19188) CALCULATIONS OF SOLAR PLASMA INTERACTION WITH MAGNETIC FIELD OF CURRENT LOOP AND TWO PARALLEL INFINITE LINES OF CURRENT. McKinzie, Daniel J. Jr.; Julius, Anthony L. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 28p. (NASA-TN-D-4304). CFSTI.

An investigation was made of the forces resulting from the interaction of the unconfined magnetic field emanating from a space vehicle with the undisturbed solar wind. The integrated theoretical drag per unit area and the acceleration of a circular current loop exposed to the solar wind at zero degree angle of incidence were determined. Also, the integrated theoretical drag and lift per unit area, the restoring moment per unit area per unit length of span were determined for the case of two parallel infinite lines of current at a 45° angle of incidence. For the case of the current loop, the drag per unit area varied over a range of proton number densities from 10^6 to 10^8 particles per cubic meter and a magnetic field parameter from 10^{-4} to 10^{-2} tesla. An examination of the particle fluxes from a major solar flare showed it to have a negligible effect on the drag when compared with that from the solar wind. Accelerations were calculated for a hypothetical superconducting coil (hollow torus) that had a permanent unconfined magnetic field. For the case of the two parallel infinite lines of current at a 45° angle of incidence, the lift to drag ratio was approximately 1 to 6.8. (auth) (STAR)

38892 (N-68-19274) IDENTIFICATION OF MOVING MAGNETIC FIELD LINES. Birmingham, Thomas J.; Jones, Frank C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1968. 16p. (NASA-TM-X-63123; X-641-68-68). CFSTI.

Magnetic field line motion and its relationship with particle $E \times B$ drifts are considered. It is shown that a unique and significant field line identification can be made whenever all field lines in a region pierce a conducting, but arbitrarily shaped surface. If the region in question is free space, particle electric drifts, in general, bear no relation with field line motion identified in this fashion. However, with a conducting plasma filling the region and allowing no parallel component of electric field ($\underline{E} \cdot \underline{B} = 0$), particles drift so as to always remain on the same magnetic line of force. These points are specifically illustrated for a time-dependent model of the earth's magnetosphere. (auth) (STAR)

38893 (N-68-19435) OGO-2 MAGNETIC FIELD OBSERVATIONS DURING THE MAGNETIC STORM OF MARCH 13-15, 1966. Langel, R. A.; Cain, J. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1967. 43p. (NASA-TM-X-63142; X-612-68-88; CONF-671060-1). CFSTI.

From IAGA Special Events Symposium, St. Gall, Switzerland.

Magnetic field data from the OGO-2 spacecraft and from surface magnetic observatories are analyzed for the period March 13-15, 1966. During this interval there occurred a magnetic storm with a Dst decrease in 122γ. The results indicate a nonsymmetric inflation of the magnetosphere (asymmetric ring current) with the field decrease in the dusk sector a factor of about three more than that in the dawn sector. Within the 10 to 30γ accuracy of the data, the field disturbance at the satellite was equal to that on the surface at the same local time. From this evidence it is concluded that the source of both Dst and DS in low latitudes are external to the satellite altitudes (410 to 1510 km). The disturbance observed near the dusk meridian commenced several hours sooner than that observed near the dawn meridian, reached its maximum intensity in 18 hours and then decayed in another 18 hours to the level seen on the dawn meridian. (auth) (STAR)

38894 (N-68-19786) RING CURRENT PARTICLE DISTRIBUTIONS DERIVED FROM RING CURRENT MAGNETIC FIELD MEASUREMENTS. Hoffman, R. A.; Cahill, L. J. Jr. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center. New Hampshire Univ., Durham). Feb. 1968. 42p. (NASA-TM-X-63147; X-611-68-92). CFSTI.

The particle energy density distribution for the symmetric portion of the April 17, 1965, magnetic storm was deduced from the measured ring current magnetic field profile. This distribution contains a basic spatial distribution and a time decay term which is a function of distance in order to accomplish the fit between the calculated magnetic effects of the particles and the measured ring current flow over a period of a day. With various assumptions as to the particle loss, the time decay yields the average energy of the particles as a function of distance, and thence the total integral omnidirectional proton flux. (auth) (STAR)

38895 (N-68-20059) POLAR MAGNETIC DISTURBANCES AND INTRUSION OF CHARGED PARTICLES INTO THE IONOSPHERE. Afonina, R. G.; Fel'dshteyn, Y. I. Translated for Volt Technical Corp., Washington, D. C., from Kosm. Issled., 6: No. 1, 150-2(1968). 6p. (NASA-CR-93794; ST-GM-PF-10691). CFSTI.

The space-time distribution of 77 bay-like disturbances were evaluated. Data were collected at 15 magnetic observatories in the Northern Hemisphere at geomagnetic latitudes $\phi > 60°$ during the winter season of the IGY. The evaluated data are used in this paper to prove the regularity of the appearance of polar magnetic disturbances. The equivalent current system at ionospheric heights is given as a generalized representation of the magnitude and direction of the perturbed vector in the horizontal plane. Positive and negative disturbances and the positions of the western and eastern electrojets are discussed. The entire pattern is analyzed in the light of observations obtained by satellites. (STAR)

38896 (N-68-20287) MODEL STUDIES OF LOW-ENERGY PLASMA IN THE OUTER MAGNETOSPHERE. Grebowsky, J. M. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Mar. 15, 1968. 151p. (NASA-CR-93819; SR-317). CFSTI.

The motion of low-energy plasma in the outer magnetosphere is considered. In particular, theoretical plasma models are set up to describe the motion of plasma along a magnetic field line, as the plasma and the "frozen-in" field follow the convection pattern inherent to the "open" model of the magnetosphere. The component of the electric field parallel to the earth's magnetic field lines plays a significant role in this investigation. Using model distribution functions the electron density is determined at every point along the open field lines as a function of the local

electrostatic potential. Given the proton density at all points along an open field line, the derived density-potential profiles are used to determine the parallel electric field variation along the field line. (auth) (STAR)

38897 (N-68-20343) MAGNETIC FIELD IN THE TAIL OF THE MAGNETOSPHERE AND ITS DIMENSIONS. Starkov, G. V.; Fel'dshteyn, Ya. I.; Shevnin, A. D. Translated for Volt Technical Corp., Washington, D. C., from Kosm. Issled., 6: No. 1, 153-4 (1968). 3p. (NASA-CR-93796; ST-GM-PF-10692). CFSTI.

The magnetic field in the tail of the magnetosphere is discussed as a function of the index of magnetic activity and the variations of the dimensions of the latter as a function of different mechanisms. (auth) (STAR)

38898 (N-68-20498) SLOW ONSET TYPE PCA EVENTS AND ASSOCIATED PRE-SSC POLAR GEOMAGNETIC DISTURBANCES. Hakura, Yukio; Nagai, Masao (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1968. 12p. (NASA-TM-X-63140; X-641-68-85). CFSTI.

A new type of polar geomagnetic disturbance was observed in connection with polar cap absorptions of slow onset type. A synoptic analysis of the February 10, 1958 event shows that the disturbance is an intensified S q^p field due to an enhanced ionization produced in the ionosphere dynamo region. Protons with energies 0.1 to 1 MeV in the solar cosmic rays may be the cause of the disturbance. (auth) (STAR)

38899 (N-68-21535) AN ANALYSIS OF ALOUETTE 1 PLASMA RESONANCE OBSERVATIONS. Benson, Robert F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 61p. (NASA-TM-X-63163; X-612-68-116). CFSTI.

The plasma resonances observed by the Alouette 1 satellite were analyzed to determine (a) whether the frequencies of the cyclotron harmonic resonances follow a harmonic relation, (b) the size of the resonant excitation region, and (c) the physical nature of the observed phenomena. The major observations were: (1) When high-order cyclotron harmonic resonances were observed the frequencies of these resonances deviate from the harmonic relation in that they correspond to lower values than do the lower-order harmonics. (2) Some of the cyclotron harmonic resonant frequencies were found to be sensitive to changes in the electron density. (3) The frequency of occurrence of the nf_H resonances with $n > 4$ was highest when the velocity of the satellite $\vec{V}_s$ was approximately parallel to $\vec{B}$. (4) The duration of most of the plasma resonances depends on the angle β between $\vec{V}_s$ and $\vec{B}$; it increases with increasing cos β for the resonances at the electron plasma frequency, but decreases for the resonance at the upper-hybrid frequency. (auth) (STAR)

38900 (N-68-21553) OBSERVATIONS OF THE MAGNETOSHEATH-SOLAR WIND BOUNDARY. Burlaga, L. F.; Ogilvie, K. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 60p. (NASA-TM-X-63155; X-612-68-3). CFSTI.

Explorer 34 plasma data are presented which provide tests of current theories of the nature of the boundary between the Earth's magnetosheath and the interplanetary medium. It is shown that a discontinuous transition between the magnetosheath and the interplanetary medium is seen simultaneously in the proton spectrum, the flow direction, and the magnetic field intensity during both geomagnetically quiet and disturbed times. Observations of the velocity field in the neighborhood of the outer boundary of the magnetosheath are presented and are compared with results of the fluid theory, which predicts a standing shock. It is shown that, along the boundary on the flank of the magnetosheath, the ratios of the magnetosheath flow speed to the interplanetary flow speed are in close quantitative agreement with a prediction of the fluid theory. This prediction is essentially independent of the Mach number and the adiabatic exponent. A highly directional flow is observed in the region $30° \leq \theta \leq 100°$, where θ is the Sun–Earth–satellite angle. The direction of this flow is in good agreement with the bow shock theory. (auth) (STAR)

38901 (N-68-21650) SIMULTANEOUS MEASUREMENTS ON THREE SATELLITES AND THE OBSERVATION OF THE GEOMAGNETIC TAIL AT 1000 R_E. Fairfield, D. H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 29p. (NASA-TM-X-63166; X-612-68-124). CFSTI.

During the last week of September 1966 the heliocentric orbiting spacecraft Pioneer 7 was behind the Earth in a position to observe the geomagnetic tail between 900 to 1050 R_E. At the same time Explorer 28 and Explorer 33 were monitoring the interplanetary medium and the magnetosheath near the Earth. Comparison of these simultaneous magnetic field measurements permits the isolation of intervals when Pioneer 7 is observing steady, enhanced-magnitude solar or antisolar directed fields characteristic of the extended geomagnetic tail which are different from the interplanetary fields convecting past the other two spacecraft. The occurrence of approximately 10 intervals of tail observation of duration from a few minutes to several hours is interpreted as a sweeping of the tail across the spacecraft as the tail responds to variations in the direction of plasma flow. Discontinuous features in the interplanetary magnetic field are also found to convect past the three spacecraft with velocities which compare well with interplanetary solar wind velocities measured by the Vela satellites at the same time. Field magnitudes near the tail at 1000 R_E are found to be weaker than the corresponding interplanetary field as is predicted by the magnetogasdynamic theory. (auth) (STAR)

38902 RELATIONSHIP BETWEEN COSMIC RAY VARIATIONS AND THE STATE OF LOWER IONOSPHERE. Velinov, P. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 2: 115-18(1968). (In Russian).

Equations for the variation of electron production by cosmic rays in the lower atmosphere are analyzed, considering the influence of cosmic-ray 11-year variations on the cosmic layer, Forbush effects, and the influence of relativistic solar cosmic rays. (R.V.J.)

38903 COEFFICIENT OF AMBIPOLAR DIFFUSION OF INHOMOGENEITIES IN THE IONOSPHERE. Fiala, Vladimir (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 230-2(1968).

A brief theoretical discussion of the ambipolar diffusion of inhomogeneities in the ionosphere is presented. (M.O.W.)

38904 ELECTRON COLLISION FREQUENCY IN THE F-REGION OF THE IONOSPHERE. Beynon, W. J. G.; Rangaswamy, S. (University Coll. of Wales, Aberystwyth). Nature (London), 218: 1237-8(June 29, 1968).

There are significant difficulties in providing reliable estimates of the collisional frequency above 100 km, and there appears to be considerable discrepancy between calculated values based on the variation of atmospheric pressure with height, and experimental values based on ground-based radio wave propagation studies. The problem of determining the collision frequency at levels above the E layer is reexamined, and an approach is described based on simultaneous absorption and h'(f) measurements (h' is vertical incidence equivalent height). The essential experimental data are simply the values of the ionospheric absorption at two frequencies, one reflected from the E region and the other from the F region, together with ionograms recorded concurrently with the absorption measurements. The total collision frequency at 150 km is estimated to be ~1100. The techniques described can readily be extended to cover multifrequency measurements, and hence provide a detailed F-region collision frequency profile. (UK)

38905 DISTRIBUTION OF POSITIVE IONS IN THE F-REGION OF THE IONOSPHERE. Tolpadi, S. K.; Singh, R. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys., 6: 176-81(1968).

The ion production rate is computed for a standard atmospheric model and by adopting the rocket and satellite measured solar flux data and corresponding ionization and absorption cross sections. Considering the various loss processes and ignoring the effects of various movements, the steady state ion distribution in the F region of the ionosphere is deduced. The calculated ion distribution in the height range of 140 to 300 km is compared with the available rocket and satellite data. The nature of variation of calculated ion distribution at higher heights is found to be in good agreement with the rocket and satellite measured values. However, at lower heights, the data do not show good agreement. In such cases the rate coefficients to fit the rocket and satellite data are computed. A moderate change in the value of rate coefficients is found to fit with the experimental data. (auth)

38906 SATELLITE OBSERVATIONS OF RADIO NOISE IN THE MAGNETOSPHERE. Bauer, S. J.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 218: 1145-7(June 22, 1968).

Observations with sounding rockets and satellites have given evidence for enhanced noise bands in the ionosphere and magnetosphere, especially between the plasma frequency f_N and the upper hybrid frequency $f_T = (f_N^2 + f_H^2)^{\frac{1}{2}}$, where f_H is the electron gyrofrequency. Recent observations with the ATS II satellite provided new information on these noise bands to altitudes of about 8,000 km, employing a Ryle–Vonberg radiometer operating at seven discrete frequencies between 450 kHz and 3 MHz. Typical examples of observed noise enhancements are shown graphically.

In addition to the pronounced noise band between plasma frequency and upper hybrid frequency, other noise enhancements corresponding to various magneto-ionic regimes are recognized in the data. These enhancements were usually about 10 to 20 dB above background, and their absolute intensity is estimated to be ~10^{-19} to 10^{-18} W/m^2/Hz/sterad. The nature and origin of these noise bands are not yet understood. Generation by energetic particles has been suggested as a possible explanation, these particles generating plasma waves, for example by the Cherenkov process. This suggestion is discussed. It is considered likely that the enhancements are a result of the interaction of energetic particles with the ambient plasma. The principal noise band between f_N and f_T, which shows relatively sharp cutoffs, can be used to determine local plasma density; other magneto-ionic cutoffs can also sometimes be uniquely identified. The electron density distribution as a function of altitude, derived from noise measurements at four frequencies, is shown graphically. It seems that observations of radio noise in the magnetosphere may be an important method not only for study of wave–particle interaction phenomena, but also for the determination of local plasma density. (UK)

38907 METHOD FOR INVESTIGATING THE IONOSPHERE BY MEANS OF ARTIFICIAL SATELLITES. Ferencz, Csaba; Papay, Zsolt (Budapest Technical Univ.). Fiz. Szemle, 18: 161-6(June 1968). (In Hungarian).

The Space Research Group of the Hungarian Academy is involved in two types of problems relating to the study of the upper atmosphere: (1) experimental and theoretical investigation of rockets used for atmospheric research; and (2) telemetering of artificial satellites. The goal of the project is to obtain additional data on the ionosphere, especially by means of electromagnetic wave analysis and examination of the Doppler curve. The work involved investigation of the propagation losses in the atmosphere due to amplitude damping; absorption of the plane waves and their reflection at critical incidence angles determined by the density of the plasma layers in the ionosphere; molecular absorption of energy, depending on the molecular dipole resonance; the effect of water-vapor precipitations; and the effect of the surface of the ground on the observed phenomena. The Doppler frequency shift represents an excellent method to determine the relative speed of the satellite. The radio-telemetric observation of satellites was started in the spring of 1965, following the orbits of OSCAR-3(1965-16F) by means of a temporary station. (TTT)

38908 CONJUGATE EFFECTS OF ATMOSPHERICALLY SCATTERED AURORAL ELECTRONS. Rees, M. H. (Univ. of Colorado, Boulder). Radio Sci., 3: 645-9(July 1968).

Calculations and experiments have shown that some fraction of an electron stream incident on a gas is scattered in the backward direction. Applied to the aurora it is found that about 15 to 20% of the electron flux returns up the field lines. These electrons are transferred to the conjugate region via the lines of force, if these are continuous between hemispheres. Losses are negligible, but a small drift in longitude may be expected. The energy spectrum of the electrons becomes softer; however, a close correspondence in occurrence of aurora must prevail. Absence of aurora would be a clear indication that the phenomenon is not associated with closed magnetic shells. A minor effect on the spectral character of the electrons scattered into the conjugate area is found, which could be associated with a difference in the model atmosphere and ionosphere. (auth)

38909 CHARACTERISTICS OF AURORAL BRIGHTNESS FLUCTUATIONS. Shepherd, G. G.; Pemberton, E. V. (Univ. of Saskatchewan, Saskatoon). Radio Sci., 3: 650-8(July 1968).

Auroral brightness fluctuations have been studied visually and photoelectrically for some time. In 1961, Campbell and Rees reviewed the information then available and drew attention to the distinct characteristics of the phenomenon. In this paper the work since that time is reviewed, with particular emphasis on the power spectral densities of the fluctuation records. The existence of distinct peaks in these spectra is noteworthy. New data are presented that show the importance of the coherency spectrum and the large spatial extent of the fluctuations. No systematic motions of the fluctuating region are found. Evidence that the fluctuation peaks result from an increased energy per particle, rather than an increased particle flux, is reviewed and discussed. Possible types of mechanisms are summarized briefly. (auth)

38910 IONOSPHERIC F2 BEHAVIOR AT CONJUGATE PLACES IN LOW LATITUDES. Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). Radio Sci., 3: 658-67(July 1968).

After a brief review of the current knowledge of ionospheric F2 conjugate behavior in low latitudes, temporal variations of f_0F2 at several low-latitude conjugate pairs are examined for the period from IGY through IQSY. Although the monthly median values of f_0F2 at conjugate stations showed poor correlations, deviations from the median values, Δf_0F2, on individual days exhibited positive conjugate correlations in all seasons for both geomagnetically quiet and disturbed periods. Furthermore, a negatively correlated temporal variation of Δf_0F2 was discovered between the equatorial zone ($L < 1.09$) and the low-latitude zone ($1.1 < L < 1.3$). All of these results indicate a strong diffusion effect along field lines. (auth)

38911 MOST RECENT STUDIES OF LOW-LATITUDE EFFECTS DUE TO CONJUGATE LOCATION HEATING. Carlson, H. C. (Arecibo Ionospheric Observatory, Puerto Rico). Radio Sci., 3: 668-73(July 1968).

The present experimental evidence for the existence of a streaming of a photoelectron flux between magnetically conjugate hemispheres is reviewed. During local night but sunlit conjugate conditions, significant effects are observed on electron temperature, ionic composition, electron density distribution, the intensity of a weak plasma resonance line, and 6300 Å airglow emissions, due to the conjugate photoelectron flux. The flux is viewed as important not only in its ionospheric and magnetospheric effects, but also as a tool to probe and study related phenomena. (auth)

38912 PRESUNRISE HEATING OF THE IONOSPHERE AT ARECIBO DUE TO CONJUGATE-POINT PHOTOELECTRONS. Kwei, M. W.; Nisbet, J. S. (Pennsylvania State Univ., University Park). Radio Sci., 3: 674-9(July 1968).

In winter, as has previously been reported, the electron temperature at Arecibo starts to increase prior to local sunrise following illumination of the conjugate ionosphere. The roles played by heat conduction along the field line and by photoelectrons that traverse the field line are investigated. Photoelectron fluxes, calculated in the manner described by Nisbet, were used to examine the mechanism of presunrise heating at Arecibo. Detailed analyses are made of the escaping photoelectron flux from the conjugate region including the effect of elastic collisions with neutrals in confining the photoelectrons. Comparisons between the theoretical heat input and observed energy losses in ambient electrons are presented. Also the theoretical and measured heat fluxes are compared. (auth)

38913 CONJUGATE F-REGION ENHANCEMENT RELATED TO THE SOUTH ATLANTIC MAGNETIC ANOMALY. Pike, C. P. (Lowell Technological Inst. Research Foundation, Mass.); Herman, John R.; Gassmann, G. J. Radio Sci., 3: 680-7(July 1968).

Airborne ionospheric measurements have been made during solar minimum years (1963–1965) off the east coast of the United States from Boston to Puerto Rico, the area conjugate to the western slope of the South Atlantic magnetic anomaly. Vertical incidence ionosonde soundings were made on 17 flights under both day and night conditions, and were compared with ground-based observations along the 75° W meridian. On several late afternoon and night flights, higher values of f_0F2 were observed over the North Atlantic Ocean compared with the same local time values observed by the ground stations. During the daytime, no such enhancements were found. To determine the east–west extent of this anomaly, an additional analysis was made using published true-height profile data (from White Sands, New Mexico, as well as from the east coast chain), which revealed that the east coast exhibits a significant enhancement of F-region ionization when compared to White Sands and manifests seasonal and diurnal variations. Earlier reported measurements in the southern conjugate region indicated that there is an effect of dumping of trapped electrons, which is most pronounced in the F layer on the western slope of the magnetic anomaly between $L = 1.75$ and 3 during December and January. No significant D- or E-region effects have been observed in both hemispheres as yet. Circumstantial evidence indicates that there are F-region ionospheric effects in the Northern Hemisphere due to energetic electrons backscattered from the southern dumping region. (auth)

38914 SUGGESTED CONJUGATE-POINT DEPENDENCE FOR INTENSE TEMPERATE-LATITUDE SPORADIC E. Smith, Ernest K. Jr. (Inst. for Telecommunication Sciences, Boulder, Colo.). Radio Sci., 3: 687-90(July 1968).

Certain statistical features of the occurrence of intense sporadic E(E_s) at temperate latitudes continue to defy explanation. These are: The dominance of the summer maximum, the double-humped diurnal curve, the abrupt collapse of the summer peak as one progresses to higher latitudes than 60° geomagnetic, and the preference for quiet over magnetically disturbed days. The location of the plasmapause is found to be appropriate to explain the collapse of the summer peak; and its variation in position a possible reason for the preference for quiet days. The summer peak itself (and possibly the shape of the diurnal curve) may be attributable to conditions in the conjugate ionosphere. (auth)

38915 SCINTILLATION OBSERVATIONS AT MEDIUM-LATITUDE GEOMAGNETICALLY CONJUGATE STATIONS. Yeh, K. C. (Univ. of Illinois, Urbana); Simonich, D.; Mawdsley, J.; Preddey, G. F. Radio Sci., 3: 690-7(July 1968).

The present investigation was concerned with scintillation observations of radio signals at 40 MHz from satellite BE-B recorded at Adak, Alaska, and at Wellington, New Zealand. The point conjugate to Adak is approximately 1000 km west of Wellington along a constant L shell. The nighttime irregularity patches that cause scintillation have a dimension 500 km in the north-south direction and much larger in the east-west direction. Therefore, Adak and Wellington are sufficiently close to being a conjugate pair to permit a meaningful correlation of scintillation study. One year's data were studied, extending from October 1964, through October 1965. The nighttime scintillation shows a semiannual variation especially equatorward of Adak and Wellington. Cross-correlation studies indicate that the conjugate effect is statistically significant at night, but not in daytime. There is also an indication of slight asymmetry with respect to L shells. When the time difference of observations at the two stations is reduced from $2\frac{1}{2}$ to $\frac{1}{2}$ hr, the correlation coefficient is increased from 0.46 to 0.56. This suggests the time variability of the phenomenon under study. (auth)

38916 CORRELATION OF AURORAL RADIO ABSORPTION BETWEEN CONJUGATE POINTS. Hargreaves, J. K.; Ecklund, W. L. (ESSA Research Labs., Boulder, Colo.). Radio Sci., 3: 698-704(July 1968).

Observations with riometers at four pairs of conjugate, or nearly conjugate, stations were studied to determine how closely auroral radio absorption is correlated at magnetically conjugate points. The available evidence suggests that, if the loss of correlation due to imperfect siting of the stations and to the movement of conjugate points is taken into account, the conjugate correlation remains surprisingly good to high latitudes and perhaps throughout the auroral region. It is suggested that conjugate points move seasonally and irregularly by 100 to 200 km at the Earth's surface. (auth)

38917 BALLOON OBSERVATIONS OF ELECTRON PRECIPITATION IN CONJUGATE REGIONS OF THE AURORAL ZONE. Brown, R. R. (Univ. of California, Berkeley). Radio Sci., 3: 705-9(July 1968).

A summary is given of balloon observations of electron bremsstrahlung bearing on conjugate relationships, with particular consideration given to temporal and spatial features of electron precipitation that offer the best means of exploring the problem for energetic particles. (auth)

38918 MEASUREMENT AND INTENSITY OF ENERGETIC ELECTRONS AT THE EQUATOR AT 6.6 R_E. Lezniak, T. W.; Arnoldy, R. L.; Parks, G. K.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Radio Sci., 3: 710-14(July 1968).

Preliminary results are presented of measurements of 50- to 1000-keV electrons at the geomagnetic equator at 6.6 R_E. Quietday electron fluxes exhibit a diurnal dip in intensity at local midnight accompanied by a softening of the electron spectrum. During geomagnetically disturbed times the 50 to 150 keV electrons exhibit large fluctuations in intensity; these fluctuations are denoted as "spikes." These spikes are largest just after local midnight and decrease in intensity as local time increases. They have a duration of about 1 hr and tend to recur with about a 2-hr period. The electron spectrum softens considerably during the spikes. Generally the variations in intensity of the electrons correlates excellently with the K_p index. (auth)

38919 CORRELATED EFFECTS OF ENERGETIC ELECTRONS AT THE 6.6 R_E EQUATOR AND THE AURORAL ZONE DURING MAGNETOSPHERIC SUBSTORMS. Parks, G. K.; Arnoldy, R. L.; Lezniak, T. W.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Radio Sci., 3: 715-19(July 1968).

During magnetically disturbed times, large intensity variations are observed for electrons of energies 50 to 150 keV at the geostationary orbit of the ATS-1 satellite. Simultaneously, the correlation experiment at the magnetic conjugate region of the satellite has shown that large fluxes of bremsstrahlung x rays from precipitated energetic electrons are observed on high-altitude balloons while magnetic bays are recorded on the ground. The conclusion reached is that the magnetospheric substorm is responsible for the simultaneous intensification of the trapped particle population at 6.6 R_E equatorial plane and of precipitated energetic electrons at the magnetic conjugate region. (auth)

38920 RECENT RESEARCH ON THE MAGNETOSPHERIC PLASMAPAUSE. Carpenter, D. L. (Stanford Univ., Calif.). Radio Sci., 3: 719-25(July 1968).

The plasmapause is a three-dimensional field-aligned boundary that divides the closed field-line portion of the Earth's magnetosphere into two physically distinct regions. The purpose of this paper is to review some of the features of the plasmapause and to describe a few of the vlf wave phenomena whose characteristics appear to be strongly influenced by the boundary. (W.D.M.)

38921 RAPID GEOMAGNETIC FIELD VARIATIONS OBSERVED AT CONJUGATE LOCATIONS. Campbell, Wallace H. (Earth Sciences Labs., Boulder, Colo.). Radio Sci., 3: 726-39 (July 1968).

In the frequency range of 4.0 to 0.002 Hz natural variations of the magnetic field of the Earth have been reported to occur at pairs of near-geomagnetically conjugate locations in the Northern and Southern Hemispheres. This paper is a review of the present knowledge of such phenomena. At conjugate auroral and subauroral latitude stations, the pulsations of irregular amplitude variation (pi) which are associated with particle precipitation, are, at times, simultaneous and of identical form, but on occasions quite dissimilar activity occurs. The pulsations with a smooth, more sinusoidal form (pc) are generally quite similar at conjugate locations. Polarization determinations of the pc's have been most recently investigated to determine the propagation characteristics of hydromagnetic waves in the magnetosphere. Similar rapid magnetic field variations at low latitude and equatorial stations are often found at many widely spaced stations not necessarily conjugate. (auth)

38922 DIFFUSION PROCESSES INFLUENCED BY CONJUGATE-POINT WAVE PHENOMENA. Cornwall, John M. (Aerospace Corp., El Segundo, Calif. Univ. of California, Los Angeles). Radio Sci., 3: 740-4(July 1968).

Radial diffusion coefficients for low-energy protons in the magnetosphere are estimated for processes involving Pc 1, 2, and 3 hydromagnetic waves. These diffusion coefficients are compared to rough estimates of diffusion due to magnetic impulses and bays, to arrive at an overall diffusion rate. An effective loss rate for pitch-angle diffusion (caused by Pc 1) is developed, and combined with radial diffusion to yield a nonlinear differential equation. Some estimates of expected proton flux levels are made on the basis of this equation. (auth)

38923 SPATIAL EXTENT OF GEOMAGNETIC EVENTS CONJUGATED TO BYRD. Walker, J. K. (Dominion Observatory, Ottawa). Radio Sci., 3: 745-50(July 1968).

Five magnetometers in an east-west line and centered on the Byrd conjugate point were operated during October 1963. The correlation of the hourly range was highest between Byrd (Antarctica) and Cape Jones (Canada), the central station, but the maximum correlation was west of the Byrd conjugate point during the morning and east after local noon. The coherency between these stations during storms or pulsations was highest for periods greater than 30 min. At periods from 1.5 to 30 min, the coherency was less than 0.5 except when pulsations occurred. The coherency was slightly higher for the amplitude of the horizontal disturbance vector than for the H component and the total force disturbance vector, while the Z component had the lowest coherency. The distribution of the Pc 5 polarization diagrams with the best fit to the Byrd diagram was centered on the Byrd conjugate point as were the pulsations with the same amplitude. (auth)

38924 POLAR MAGNETIC SUBSTORMS IN THE CONJUGATE AREAS. Meng, C.-I.; Akasofu, S.-I. (Univ. of Alaska, College). Radio Sci., 3: 751-7(July 1968).

Using simultaneous records of polar magnetic substorms from two pairs of geomagnetically conjugate stations (College-Macquarie; Reykjavik-Syowa), the magnitude of positive bays is shown to be mainly controlled by the ionization produced by solar wave radiation, not by the intense auroral particle bombardment which is the major factor for negative bays. Also shown is that the pattern of the polar electrojet with respect to the dipole is displaced or different in the two polar caps, particularly in the solstitial months. The electrojet appears farther toward the pole in the winter polar cap than in the summer one. These results bear on the configuration of the field lines in or near the magnetospheric tail, if auroral particles originate there. (auth)

38925 SIMULTANEOUS MAGNETIC FIELD VARIATIONS AT THE EARTH'S SURFACE AND AT SYNCHRONOUS, EQUATORIAL DISTANCE. PART I. BAY-ASSOCIATED EVENTS. Cummings, W. D.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). Radio Sci., 3: 758-61(July 1968).

Some preliminary results of the UCLA magnetometer experiment on board ATS-1 are reported. The magnetometer experiment consists of two orthogonal flux gates, coplanar with the spin axis. The sensing axes of the magnetometers are inclined 45° to the satellite spin axis. By taking the difference and sum of the outputs of

the two detectors, one can measure the magnetic field perpendicular and parallel to the spin axis. About 12 equally spaced measurements of the field perpendicular to the satellite are made each second, and the field parallel to the spin axis is sampled at half this rate. (W.D.M.)

38926 SIMULTANEOUS MAGNETIC FIELD VARIATIONS AT THE EARTH'S SURFACE AND AT SYNCHRONOUS, EQUATORIAL DISTANCE. PART II. MAGNETIC STORMS. Coleman, P. J. Jr.; Cummings, W. D. (Univ. of California, Los Angeles). Radio Sci., 3: 762-5(July 1968).

Initial results of a study of magnetic activity at 6.6 R_E during magnetic storms are reported. The field measurements at 6.6 R_E were obtained with a magnetometer on board the synchronous, equatorial satellite, ATS-1. The discussion primarily concerns measurements of the H component of the field at ATS-1 and comparisons of the H component at ATS-1 with the H component at Honolulu. (W.D.M.)

38927 ROLE OF THE MAIN GEOMAGNETIC FIELD IN LOCATING CONJUGATE POINTS. Cain, Joseph C. (Goddard Space Flight Center, Greenbelt, Md.). Radio Sci., 3: 766-71(July 1968).

A sample distribution of conjugate points is calculated from various models of the main geomagnetic field, evaluated at different epochs. A summary of the conclusions is: (1) For $L < 4$ the errors are of the order of a few tens of kilometers; (2) older models of the field such as the Finch–Leaton give results within a few degrees of the latest more accurate models; (3) use of the eccentric dipole approximation gives errors that range from a few tens of kilometers at high latitude to several hundred kilometers near the equator; and (4) the secular change of conjugate-point locations is very small, averaging 1 to 10 km/yr. Inclusion of Mead's boundary field for a trace from Macquarie Island to Alaska ($L = 5$) shifts the conjugate only about 100 km. It is concluded that for $L \geq 5$ the field line passes through regions where the field intensity is weak enough to require that realistic estimates of the distortions due to plasma interactions be included in conjugate-point determinations. (These estimates are not now available.) (auth)

38928 CONJUGATE OPTICAL MEASUREMENTS: TOTAL NIGHT HOURS POSSIBLE FOR ONE YEAR. Marovich, E. (Aeronomy Lab., Boulder, Colo.). Radio Sci., 3: 772-3(July 1968).

Results are presented of calculations leading to maps of the Northern and Southern Hemispheres that show contours, per annum, of the number of simultaneous nighttime hours at magnetically conjugate observations. (auth)

38929 CONSIDERATION OF FACTORS GOVERNING AIR CONDUCTIVITY PRODUCED IN NUCLEAR EXPLOSIONS. Thoresen, P. (Norwegian Defence Research Establishment, Kjeller). Phys. Norv., 2: 251-5(1967).

To determine the electromagnetic fields produced from a nuclear explosion the electron density as a function of time has to be evaluated. In the literature the electron density has been determined by the production rate (from the emitted gamma rays) and the attachment rate of electrons to oxygen molecules. The importance of the detachment processes of the electrons from the O_2^- ions has not been discussed in the available publications. In this paper it is shown that the detachment rates are of comparable magnitude to the other processes determining the density of free electrons. In the periods of time $10^{-6} < t < 10^{-2}$ sec, which are of great importance in the development of the EM fields, the equilibrium condition of attachment–detachment processes may determine the electron density. The calculated electron density will be larger when the detachment processes are considered. (auth) (Norway)

38930 EFFECT OF SOLAR ACTIVITY ON THE S_q VARIATION OF THE GEOMAGNETIC FIELD. Chikovani, Dzh. S. Soobshch. Akad. Nauk Gruz. SSR, 50: No. 1, 71-6(Apr. 1968). (In Russian).

Some results of an investigation of the dependence of the variation of the geomagnetic field on the change of solar activity are reported. The amplitudes of each quiet day were calculated with consideration of the noncyclical changes of the geomagnetic field for July and August of 1957–1959 and 1963–1965. The mean amplitude for periods of high solar activity was of the order of 34 γ, and for periods of low activity, 36 γ. The magnetic perturbations and other geomagnetic phenomena, connected with solar activity, have a tendency to recur every 27 days. (J.S.R.)

38931 VARIATION OF THE FIRST ADIABATIC INVARIANT OF A PARTICLE IN A DIPOLE MAGNETIC FIELD. Il'in, V. D. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 882-3(1967).

Translated from Geomagn. Aeron., 7: 1087-8(1967).

A rigorous quantum mechanical analysis of the variation of the adiabatic invariant of a particle moving in an axially symmetric, inhomogeneous magnetic field was presented by Dykhne and Chaplik (1961). The variation of the adiabatic invariant was also computed on the assumption that the zero S_0 of the function $\omega(s)$ (ω is the Larmor frequency in a complex plane and s is the length along a line of force) contributes most to the matrix elements of the scattering matrix. The factor in front of the exponential of the scattering matrix is calculated. (W.D.M.)

38932 DEPENDENCE OF THE BOUNDARY OF THE MAGNETOSPHERE ON THE NONDIPOLE PART OF THE GEOMAGNETIC FIELD, ACCORDING TO MAGNETIC OBSERVATIONS OF IMP-1. Rudneva, N. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 880-1(1967).

Translated from Geomagn. Aeron., 7: 1085-6(1967).

The dependence of the distance, r, from the Earth to the magnetosphere boundary on local time was established by Kalinin (1967). The dependence of r on geographic and geomagnetic coordinates was investigated by Rudneva (1967) on the basis of magnetic observations of Explorer 12. The same problem is examined on the basis of observational data from IMP-1. All the characteristics of motion of the satellite, necessary to compute its coordinates, were taken from Ness, et al., J. Geophys. Res., 69: 31(1964). (W.D.M.)

38933 VARIATIONS IN THE RATE OF ELECTRON PRODUCTION IN THE LOWER PART OF THE D REGION OF THE IONOSPHERE. Velinov, P. (Geophysical Inst., Sofia). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 885-7(1967).

Translated from Geomagn. Aeron., 7: 1090-2(1967).

An equation was obtained by Velinov (1967) describing the relative variations of electron production, $\delta q(h)/q(h)$, by corpuscular and wave emissions. Here $\delta q(h)$ is the change of q(h) with time. An equation for $\delta q/q$ in the lower part of the D region ($N_e \sim 10^2/cm^3$), produced by primary cosmic radiation, is derived by using the method described by Velinov. (W.D.M.)

38934 ELECTRON TEMPERATURE IN THE F2-LAYER MAXIMUM. Shapiro, B. S.; Potapova, N. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 887-9(1967).

Translated from Geomagn. Aeron., 7: 1093-5(1967).

The variations in the electron temperature, T_e, and in the quantities T_e/T_i and $(T_e - T_n)$, as computed from data on the geometric parameters of N(h) and also from H_n and T_n data from the CIRA-65 model of the atmosphere, are presented. (W.D.M.)

38935 SEASONAL ANOMALY OF THE F2 LAYER AND VARIATIONS IN THE COMPOSITION OF THE ATMOSPHERE. Kazachevskaya, T. V. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 889-92(1967).

Translated from Geomagn. Aeron., 7: 1096-8(1967).

Using the conclusions derived by Geisler and Bowhill on the theory of formation of the F2 layer, where allowance is made for the influence of diffusion, and taking recent data on n_e and on the heights of the layer, h_{max} F2, an attempt is made to estimate the seasonal variation of the atmosphere in the region of the F2 maximum. (W.D.M.)

38936 EXPERIMENT IN THE SPACE–TIME FORECASTING OF THE CRITICAL FREQUENCY ON THE F2 LAYER. Gubenko, V. S.; Rodionov, Ya. S. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 892-4(1967).

Translated from Geomagn. Aeron., 7: 1099-1100(1967).

A simple model is used that does not allow for all factors, but permits an easy solution on the basis of the method described by Gubenko (1965). As an example, a forecast is given for the point at which Krasnaya Pakhra is located on the basis of data from three stations: Leningrad, Sverdlovsk, and Rostov-on-the-Don. Three methods of space–time forecasting are compared. (W.D.M.)

38937 REDISTRIBUTION OF IONIZATION IN THE E REGION OF THE IONOSPHERE. Pozigun, V. L.; Chavdarov, S. S. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 894-6(1967).

Translated from Geomagn. Aeron., 7: 1101-2(1967).

The N(h) profiles were computed for some cases of E_s. E_s of the l and c types with high limiting frequencies, but with a short lifetime, that are transparent at all frequencies, were selected. This made it possible to obtain with confidence (within the limits of accuracy of the method of computation) the distribution of electron concentration with height and its time variation. The N(h) profiles were computed by Titheridge's method. (W.D.M.)

38938 IONOSPHERIC DISTURBANCES AT MIDDLE LATITUDES. Khocholava, G. M.; Gachechiladze, R. G. (Inst. of Geo-

physics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 896-8(1967).

Translated from Geomagn. Aeron., 7: 1103-4(1967).

Munro and Heisler (Austral. J. Phys., 9: 343(1956)) have shown that a median, computed from magnetically quiet days ($\Sigma K_p \leq 10$ to 12), can be used for all latitudes without exception and that the deviations of critical frequencies from this median can be computed. The behavior of the F2 region in the latitude interval 0 to 60°N was examined during geomagnetic storms and an attempt is made to explain the nature of this behavior. (W.D.M.)

38939 DIMENSIONS OF VERTICALLY MOVING IONIZED FORMATIONS. Vasil'ev, K. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 898-9(1967).

Translated from Geomagn. Aeron., 7: 1105-6(1967).

An estimate is made of the dimensions of vertically moving ionized formations on the basis of aircraft observations and the ionospheric data of four ground observatories. Observations made simultaneously in Leningrad, Moscow, Kiev, and Rostov-on-the-Don gave a considerable scatter of the time of appearance of vertical movements in the F region. (W.D.M.)

38940 STABILITY OF THE SPORADIC E LAYER. Gershman, B. N.; Ignat'ev, Yu. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 900-1(1967).

Translated from Geomagn. Aeron., 7: 1107-8(1967).

There is a theory of the sporadic E that associates it with horizontal winds with vertical velocity shears. Computations for several E_s models in the steady-state regime have been performed within the framework of this theory. The question arises as to the stability of stationary states corresponding to the presence of E_s. Such a study of stability for disturbances with small amplitudes was performed previously with application to the initial stage of E_s formation. The problem of the stability of E_s when it is developed is examined. (W.D.M.)

38941 STRATIFICATIONS IN THE IONOSPHERIC SPORADIC E. Ovezgel'dev, O.; Lezhneva, A. V. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 902-3(1967).

Translated from Geomagn. Aeron., 7: 1109-11(1967).

Stratification in the E_s layer is observed in the form of two or three layers of the same type, one above the other. The results of investigations of stratifications in E_s, based on data from Ashkhabad for the period 1958–1966, are presented. (W.D.M.)

38942 FREQUENCY CHARACTERISTICS AND FINE STRUCTURE OF E_s. Ovezgel'dev, O.; Babaev, A. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 904-6(1967).

Translated from Geomagn. Aeron., 7: 1112-13(1967).

The data from 14 ionospheric stations in the eastern hemisphere for the summer of 1958 were used to study the possible interrelationships between the frequency characteristics f_bE_s and F_bE_s. For Ashkhabad the analysis was performed also up to the equinox and for the winter. (W.D.M.)

38943 SPORADIC E LAYER OVER KAZAKHSTAN DURING THE ECLIPSE OF MAY 20, 1966. Starovatov, A. A. (Ionospheric Section, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 906-7(1967).

Translated from Geomagn. Aeron., 7: 1114-15(1967).

During the eclipse of May 20, 1966, there was a rather dense E_s layer at Alma-Ata and the changes in it were clearly observed because of the occultation of the solar disc. The limiting frequencies of the E_s layer during the eclipse dropped considerably below the most probable minimum f_bE_s values on control days. The f_bE_s also experienced a significant change during the eclipse. (W.D.M.)

38944 RECURRENCE OF AURORAL BURSTS. Roldugin, V. K. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 907-9(1967).

Translated from Geomagn. Aeron., 7: 1116-17(1967).

Most electrophotometric records of aurorae represent a group of peaks that differ in amplitude and in the distance between them. Therefore, it is interesting to determine whether there is a periodicity in the bursts during the development of an aurora. To determine the most frequently recurring intervals between peaks in the range from 1 min to 1 hour, the photometric records at Loparskaya in 1965–1966 were analyzed; 41 aurorae were selected with a total of 461 peaks. (W.D.M.)

38945 RECURRENCE OF SC STORMS. Berishvili, G. P. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 909-11(1967).

Translated from Geomagn. Aeron., 7: 1118-19(1967).

In examining the Tbilisi catalog of magnetic storms, which covered the period from 1900 to 1964, it was found that of most sudden commencement storms 71% fall into sequences of some multiplicity, i.e., are recurrent. This result disagrees with the existing point of view that sc storms are not recurrent. Therefore, a more detailed study was undertaken of the characteristics of the frequency of these storms, using the superposition of epochs method. (W.D.M.)

38946 IRREGULARITIES IN THE DISTRIBUTION OF THE DISTURBANCE VECTORS OF GEOMAGNETIC BAYS. Litinskii, V. M. (Lvov State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 911-12(1967).

Translated from Geomagn. Aeron., 7: 1120(1967).

When studying geomagnetic bays in Lvov it was found that the predominant azimuth of the major axes of vectorgrams is directed to the northeast. A similar inclination of major axes was found at other observations at middle latitudes in Central and Western Europe. If the probability of appearance of current systems were the same at all longitudes, the distribution of the major axes would be symmetric with respect to the magnetic meridian. In constructing the current systems of bays that correspond chiefly to systems obtained previously, it was found that the distribution of the latter in Europe is such that their centers appear more frequently east of the 40° meridian. (W.D.M.)

38947 DISTRIBUTION OF SHORT-PERIOD PULSATIONS WITHIN GEOMAGNETIC STORMS. Gogatishvili, Ya. M. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 912-14(1967).

Translated from Geomagn. Aeron., 7: 1121-3(1967).

It is known that geomagnetic disturbances, particularly short-period pulsations (SPP), result from the interaction of a corpuscular stream with the geomagnetic field. Interesting information for the study of this interaction can be obtained from an investigation of the distribution of SPP during a magnetic storm, using the data of the global network of stations. The distribution of SPP with periods of 10 to 15 sec during storms is examined by analyzing the records of 16 storms, 6 of which were recorded at Alushta (1957-1958) and 10 at Dusheti (1962-1963). (W.D.M.)

38948 POSSIBLE INFLUENCE OF IONOSPHERIC CONDITIONS ON THE FORMATION OF PULSATION INTERVALS OF DECREASING PERIOD IN THE ELECTROMAGNETIC FIELD OF THE EARTH. Troitskaya, V. A.; Mal'tseva, N. F. (Inst of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 915-16(1967).

Translated from Geomagn. Aeron., 7: 1124-5(1967).

Three assumptions regarding the reasons for the excitation or formation of pulsation intervals of decreasing period (PDP), belonging to the class of hydromagnetic emissions, are discussed. A qualitative experimental test of the mechanisms of PDP excitation or formation is proposed. (W.D.M)

38949 SOME RESULTS OF A SPHERICAL HARMONIC ANALYSIS OF THE GEOMAGNETIC FIELD FROM COSMOS 49 DATA. Tyurmina, L. O.; Cherevko, T. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 917(1967).

Translated from Geomagn. Aeron., 7: 1126(1967).

It has been shown that it is possible to perform a spherical harmonic analysis of the geomagnetic field from measurements of T only, i.e., of the total field intensity. The results of experimental computations of the coefficients of analysis g_{nm} and h_{nm} to n = m = 6 from small samples of T measurements have been previously reported. In developing these studies on the basis of Cosmos 49 data, the coefficients g_{nm} and h_{nm} were computed to n = m = 9 (99 coefficients). The analysis was performed with allowance for the flattening of the Earth. The coefficients were computed separately from two independent samples of measurements of up to 4000 values each and then averaged. The results are presented in gammas. The average difference from the values measured on Cosmos 49 was ±15γ, there was no disagreement in level. (W.D.M.)

38950 EQUATION FOR AN ELECTROSTATIC FIELD GENERATED IN THE DYNAMO REGION OF THE IONOSPHERE. Ivanov, K. G.; Latypova, R. Kh. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 800-2(1967).

Translated from Geomagn. Aeron., 7: 985-7(1967).

A general equation is derived for an electrostatic field generated as a result of the dynamo effect in the dynamo region of the ionosphere. (auth)

38951 VERTICAL DISTRIBUTION OF THE VARIABILITY OF ELECTRON DENSITY IN THE IONOSPHERE. Sukhorukova,

E. V. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 803-5(1967).
Translated from Geomagn. Aeron., 7: 988-91(1967).

The electron density at fixed heights was obtained on the basis of computations of N(h) profiles in the polar ionosphere. The computations were performed for five magnetically quiet days of each month. An estimate was made of the variation of electron density under similar ionospheric conditions. (auth)

38952 DISTURBANCES IN THE F2 LAYER DURING POLAR MAGNETIC STORMS. Dolgova, E. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 806-9(1967).
Translated from Geomagn. Aeron., 7: 992-6(1967).

The relationship between disturbances in the F2 layer and polar storms is demonstrated on the basis of observations at 35 ionospheric stations in the northern hemisphere. The possibility of explaining the characteristics obtained for the diurnal pattern of disturbance of the upper atmosphere from the viewpoint of the theory of ionization drifts in the F2 layer is examined. (auth)

38953 FREQUENCY-DEPENDENCE OF RADIO WAVE ABSORPTION IN THE IONOSPHERE. Belkina, L. M. (Section on the Ionosphere, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 810-12(1967).
Translated from Geomagn. Aeron., 7: 997-1000(1967).

The data from the global network of stations measuring absorption during the IGY showed that the quadratic variation of absorption with frequency does not hold. The frequency pattern of absorption depends on the latitude of the observation point, the solar activity level, and the season. (auth)

38954 LUNAR-DIURNAL GEOMAGNETIC FIELD VARIATIONS AT IBADAN AND THEIR RELATION TO IONOSPHERIC TIDES. Zagulyaeva, V. A.; Martynova, K. V.; Prilezhaeva, N. A.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow, Irkutsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 813-17(1967).
Translated from Geomagn. Aeron., 7: 1001-6(1967).

The lunar variations of the geomagnetic field and the parameters of individual layers of the ionosphere were computed from the results of magnetic and ionospheric observations at Ibadan during the IGY. The magnetic field variations are compared with lunar tides in the ionosphere. It is found that the phase of the second harmonic correlates with the phases of tidal ionization fluctuations in the E region and with fluctuations in the height of the F2 region. Additional arguments are advanced in favor of the assumption that the currents responsible for the L variation of the geomagnetic field are localized in the E region. (auth)

38955 SOME PROBLEMS IN THE INTERPRETATION OF OSCILLOGRAMS FROM OBLIQUE SOUNDINGS. Chernov, Yu. A. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 818-22(1967).
Translated from Geomagn. Aeron., 7: 1007-13(1967).

The behavior of signals at different hours of the day during oblique soundings at a single frequency was examined. Main attention was paid to the determination of the location of the signal along the F2 layer. It is shown that in most cases the above can be done by the method of elimination if the position of the signals along E and F1 is determined by computations. From the computations it follows that the signal level decreases sharply along E as compared to the signal along F2 for a summer day at distances exceeding 1500 km. This fact makes it possible to determine with great certainty the location of the F2 signal at great distances. (auth)

38956 MOTION OF AN IONIZED PLANE LAYER IN HOMOGENEOUS MAGNETIC FIELD DIRECTED AT AN ANGLE. Rybin, V. V. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 823-7(1967).
Translated from Geomagn. Aeron., 7: 1014-20(1967).

Expressions are obtained for the drift velocity of an infinite, plane ionized layer with a charged-particle density other than the charged-particle density in the surrounding plasma under the effect of a wind or of an external electrostatic field in the ionosphere. Allowance is made for the influence of the external plasma and of the geomagnetic field whose intensity vector is directed at an arbitrary angle to the plane of the layer. It is shown that the drift velocities of a layer parallel to the magnetic field may differ by 2 or 3 orders of magnitude from the drift velocities of a layer to which the magnetic field is directed at an angle, even if the angle between the intensity vector of the magnetic field and the plane of the layer is rather small (less than 3 to 5°). This means, apparently, that the formulas for the drift velocity of a layer parallel to the magnetic field are not applicable at all to real ionospheric formations. Drift under the effect of a wind parallel to the layer is examined separately. (auth)

38957 HYDROGEN DISTRIBUTION IN THE UPPER ATMOSPHERE OF THE EARTH, ACCORDING TO OBSERVATIONS OF HI 6563 A IN THE AIRGLOW SPECTRUM. Fishkova, L. M.; Martsvaladze, N. M. (Abastumani Astrophysical Observatory, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 828-31(1967).
Translated from Geomagn. Aeron., 7: 1021-5(1967).

The vertical distribution of the total content and concentration of neutral hydrogen atoms in the thermosphere and exosphere, obtained from spectral observations of the intensity of H_α emission of the night sky, is described. The results are compared with theoretical models and also with the results of rocket observations of the L_α emission of the night sky. (auth)

38958 NATURE OF THE EFFECT OF THE TUNGUSKA FALL ON THE UPPER ATMOSPHERE, THE GEOMAGNETIC FIELD, AND AIRGLOW. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 836-9(1967).
Translated from Geomagn. Aeron., 7: 1031-5(1967).

The assumption of the cometary nature of the Tunguska fall of 1908 is used to analyze the possible scheme of the development of the magnetic–ionospheric disturbance and atmospheric emission that have resulted from this fall. As a result of the explosion of the nucleus of the comet, a large amount of light chemically active substances was ejected into the upper atmosphere above the site of the fall. The change in the chemical composition of the atmosphere above East Siberia has led to the disturbance of the usual pattern of photochemical and photoionization processes in the upper atmosphere and, as a consequence, to the formation of a region of enhanced electric conductivity in the ionosphere, of a geomagnetic disturbance, and of atmospheric emission. (auth)

38959 GEOMAGNETIC STORM OF APRIL 1–2, 1964, AT THE SURFACE OF THE EARTH AND IN THE TAIL OF THE MAGNETOSPHERE. INSTABILITY OF THE NEUTRAL SHEET. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 840-3(1967).
Translated from Geomagn. Aeron., 7: 1036-40(1967).

Observations of the geomagnetic storm of April 1–2, 1964, in the tail of the magnetosphere are compared with polar disturbances at the ground. The presence of the first phase of the disturbance in the tail of the magnetosphere and in the polar cap as well is noted. A positive correlation is found between the field of the polar disturbance and the magnetic field in the tail during the main phase of the storm. It is assumed that the characteristics of this storm are produced by the oblique advance of the flux toward the magnetosphere. The possibility is mentioned of a trough-like instability of the boundary of the neutral sheet owing to its distortion upon oblique advance. (auth)

38960 ALLOWED INTERVALS WITHIN 24-HOUR PERIODS WITH AN INCREASED PROBABILITY OF THE APPEARANCE OF THE ACTIVE PERIODS OF MAGNETIC STORMS. Nikol'skii, A. P. (Arctic and Antartic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 844-50(1967).
Translated from Geomagn. Aeron., 7: 1041-9(1967).

The results of observations on days with strong magnetic storms in 1958 at 41 stations in the Arctic and Antarctic are analyzed. Other, additional data are used. It is shown that the complex distribution of active periods in the course of a day can be explained by the penetration of solar particles along allowed Störmer trajectories toward a dipole from two effective contact regions between the geomagnetosphere and recurrent streams at 14.3h geomagnetic time, and for flare-type streams at 11.2h, on the average. Proceeding from the geometry of solar corpuscular streams, it was found possible to compute the velocity of these streams, which was found to agree well with known earlier data. (auth)

38961 STUDIES OF THE LOWER IONOSPHERE OVER A COMPLETE SOLAR CYCLE. Vice, R. W. (South African Council on Scientific and Industrial Research, Johannesburg). J. Inst. Telecommun. Eng., 12: 192-7(1966).

A series of investigations of the lower ionosphere carried out since 1954 are described. Measurements were made of absorption, virtual height, partial reflections, and wave interaction, and the results used to establish profiles of electron density and collision frequency. (Indian Sci. Abst.)

38962 ROCKET OBSERVATIONS OF EMITTING HEIGHT OF NIGHT AIRGLOW. Nakamura, Tsuyoshi. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1097-1106(Sept. 1966). (In Japanese).

Photoelectric measurements are presented of the heights of emitting layers of night airglow. The layers of the 5577-Å green

line of atomic O and 5893-A sodium D line were observed on Oct. 30, 1961, and the layers of the 6300-Å red line of atomic O were observed on March 25, 1965 and March 20, 1966. (IAA) (Meteorol. Geoastrophys. Abstr.)

38963 SOME RESULTS OF VERTICAL IONOSPHERIC SOUNDINGS AT VOSTOK STATION IN 1960. Golysheva, M. A.; Kolomiitsev, O. P. Tr. Sov. Antarkt. Eksped., 48: 315-21(1967). (In Russian).

The soundings at Vostok (78°27'S, 106°52'E, geomagnetic ϕ = −89°10', Λ = 92°38') were made with a type AIS ionospheric station. This paper is a brief survey of the state of the ionosphere in the region of the south geomagnetic pole based on the analysis and examination of the obtained data. Presented standard curves of diurnal variations of median values of critical frequencies of the F2, F1, E and f_{min} layers for June–Dec. 1960 show that, like in middle latitudes, the ionization of the F1 and E layers followed $h_{\odot}$. A maximum ionization is clearly seen at noon local time. A graph constructed by the superposition of epochs method shows that greatest foF2 variability was typical for magnetic storm days. Tabulated 10 periods of observed anomalous absorptions are discussed. Tables of distribution of sporadic ionization by E_s types show that at Vostok the principal E_s (93%) was the "flat." The f and l types of E_s predominated in the winter and c and h types in the summer. An analysis showed that a "transparent" E_s occurred for the most part during 1000–1700 predominately in the summer. It was found that during global magnetic storms a considerable reduction of the frequency of F2 layer is observed in all seasons; it is most pronounced during daytime hours at the equinox. (Meteorol. Geoastrophys. Abstr.)

38964 PHYSICAL NATURE OF LONG-PERIOD PULSATIONS OF THE GEOMAGNETIC FIELD. Ol, A. I. Tr. Arkt. Antarkt. Naucho-Issled., 280: 37-47(1966). (In Russian).

Records of the magnetic field at polar observatories exhibit strong irregularities and noise. However, sometimes regular sinusoidal oscillations appear with periods of several hundred seconds and amplitudes reaching a few hundred gammas. The study of these "long-period pulsations" made it possible to estimate some physical processes occurring near the boundary of the magnetosphere. The hydromagnetic waves producing the described Pc5 pulsations may originate in the M regions of the Sun, which eject recurrent corpuscular beams. Recently (Bahng et al., 1963) periodic vertical oscillations of the radial velocity of solar flocculi with a 4- to 5-min period were revealed. Probably these oscillations are sound waves originating in lower solar layers and propagating towards the corona. If these waves are not completely absorbed in the corona and propagate toward the magnetosphere without strong attenuation, they excite resonant oscillations in the terrestrial magnetosphere. (Meteorol. Geoastrophys. Abstr.)

38965 FINE STRUCTURE OF THE DIURNAL DISTRIBUTION OF THE FREQUENCY OF APPEARANCE OF IRREGULAR MAGNETIC DISTURBANCES. Nikol'skii, A. P. Tr. Arkt. Antarkt. Naucho-Issled., 280: 5-12(1966). (In Russian).

The space–time distribution of magnetic disturbances and the anomalous absorption in the ionosphere are investigated. A fine structure in the diurnal distribution of frequency appearance of irregular magnetic disturbances was found to be more complicated than had been assumed. Besides 4 intervals in 24 hrs with enhanced frequency of appearance of irregular magnetic disturbances, 2 additional maxima were established at zonal stations at 2 and 19 hrs. These disturbances are probably connected with intrusion of bursts of corpuscular beams, while the appearance of 4–5, 10–11, 15–16 and 23–24 hrs is related to the intrusion of recurrent corpuscular streams. The time of these maxima, after reduction to geomagnetic time of the corresponding effective source of emission, practically coincides with the time of shock zones on the deposit spiral of Störmer particles. (Meteorol. Geoastrophys. Abstr.)

38966 RESONANCE OF A PLANE HM-WAVE IN THE LOWER MAGNETOSPHERE AND Pc PULSATIONS WITH PERIODS OF 5 TO 40 SECONDS OCCURRING DURING GEOMAGNETIC STORMS. Prikner, Karel (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 224-30(1968).

Pulsations with periods ranging from 5 to 40 secs observed in lower geomagnetic latitudes are described. Calculations were made for obtaining the absolute value of the ratio of the magnetic field amplitude of the wave on transit through the layers (at the Earth's) surface, and the amplitude of the wave incident at the first discontinuity within the system of layers. This ratio is called the coupling frequency at a given frequency and is analogous to the amplitude transmission coefficient. (M.O.W.)

38967 DIFFUSION OF SMALL INHOMOGENEITIES IN THE IONOSPHERE. Fiala, Vladimir (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 199-205(1968).

The effect of the nonpotential component of the electric field on the diffusion of inhomogeneities which drift, e.g., due to the motion (wind) of the neutral component of ionospheric plasma or due to the external electric field, was investigated. (M.O.W.)

Low-Temperature Physics

Refer also to abstracts 38132, 38510, and 39153.

38968 FLUX PINNING BY GRAIN BOUNDARIES IN A TYPE-II SUPERCONDUCTOR. Gifkins, K. J.; Malseed, C.; Rachinger, W. A. (Monash Univ., Victoria, Australia). Scr. Met., 2: 141-3 (Feb, 1968).

In studying the role of grain boundaries in flux pinning, one difficulty is in the production of specimens having a large range of grain size. This difficulty has been avoided in work in which the anisotropy of critical current was measured in a cold-rolled alloy and the results interpreted in terms of pinning by the elongated grain structure in both longitudinal and transverse configurations. A large variation in grain size can be produced in recrystallized lead–thallium alloys. In the present investigation the grain diameter was varied by a factor of 65. (auth)

38969 ASPECTS OF A MODEL OF SUPERFLUIDITY. Johnston, J. R.; Cummings, F. W. (Univ. of California, Riverside). Nuovo Cim., 56B: 12-22(July 11, 1968).

Some features of a recently proposed model of superfluid bosons are examined. The equation of motion of the condensate wave function is derived and an expression for the chemical potential is obtained. It is shown that the excitation spectrum exhibits a gap in the long-wavelength limit which is identical to that obtained by Girardeau and Arnowitt. The pair correlation function is likewise shown to be very similar. (auth)

38970 THE RESONATING-VALENCE-BOND THEORY OF SUPERCONDUCTIVITY: CREST SUPERCONDUCTORS AND TROUGH SUPERCONDUCTORS. Pauling, Linus (Univ. of California, San Diego, La Jolla). Proc. Nat. Acad. Sci. U. S., 60: 59-65(May 1968).

Critical temperatures were calculated for Y, Zr, Nb, Mo, Tc, Ru, and Rh superconductors using the resonating-valence-bond theory. A discussion of the theory is presented. (M.O.W.)

38971 ELECTROLYTIC MODELING OF THE DISTRIBUTION OF STATIC MAGNETIC FIELDS NEAR SUPERCONDUCTING SURFACES. Slabkii, L. I.; Egorov, A. S.; Kosarin, P. E. (Military Air Engineering Academy, Moscow). Prib. Tekh. Eksp., No. 2, 198-9(Mar.-Apr. 1968). (In Russian).

The use of electrolytic modeling for determination of the distribution of magnetic lines of force near a superconducting surface was described. The results of the electrolytic measurement of the field were reported for different configurations. (tr-auth)

38972 MICROWAVE SURFACE RESISTANCE OF SUPERCONDUCTING LEAD, TRAPPED MAGNETIC FLUX, AND A NEW MAGNETOMETER USING SUPERCONDUCTIVITY. Pierce, John Morley. Stanford, Calif., Stanford Univ., 1967. 83p. -Thesis.

An investigation has been made into the causes of the residual surface resistance always observed in superconductors at microwave frequencies. A surface with residual loss two orders of magnitude less than previously observed was achieved in 1964, when a Q of 5×10^9 in a TE_{011} mode cavity operating at 2856 MHz was observed. The effects of high rf magnetic fields on the surface were also measured, and no degradation of the Q for fields up to 300 gauss was found. Recently, experiments on the effects of trapped flux on the surface resistance were done with a cavity in which the Q's of three modes could be measured after the cavity was cooled in a very low field and in various applied magnetic fields. The results of cooling the cavity in an applied field can be explained by assuming that a fraction ($H_{applied}/H_{critical}$) of the cavity is maintained normal by trapped flux. These normal regions "hide" down in depressions on the surface. The fact that the frequency dependence of the loss due to trapped flux is $\omega^{\frac{1}{2}}$ supports this hypothesis. The residual loss observed even in the very best surfaces made, even when they are cooled in a very low magnetic field, is still due largely to trapped flux. But this trapped flux is produced by thermoelectric currents generated when the cavity is cooled; it is not from an external field. By cooling very slowly in a low field a residual Q of 5×10^{10} in a cavity resonant at 12.2 GHz in the TE_{013} mode was recently achieved. A new and

extremely sensitive magnetometer has been developed, which uses unique properties of superconductivity. The magnetometer uses a superconducting loop in which a field change is translated into a persistent current. Linking the loop is a cylinder of superconductor that can be switched alternately between the normal and superconducting states at a frequency of 150 kHz. Since the magnetic flux linking a superconducting cylinder is quantized, inductive impulses are given to the loop, and a large oscillation is built up, which is proportional to the persistent current. The result is an output power equivalent to spinning the sensing loop at a frequency ~10^7 Hz. This accounts for the great sensitivity. (TSS) (Disser. Abstr.)

38973 ULTRASONIC ATTENUATION IN HIGH-PURITY NORMAL AND SUPERCONDUCTING THALLIUM. Willard, Harold James Jr. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 126p.

Thesis.

The attenuation of longitudinal ultrasound was measured with the pulse-echo technique in single-crystal thallium at temperatures between 0.5 and 4.2°K and at frequencies from 10 to 130 MHz. The samples were grown with the strain-anneal technique from material of 99.999% nominal purity. The attenuation measurements included a search for amplitude-dependent effects. No effects were observed in either the normal or superconducting states for transducer voltages of 0.5 to 80 volts peak-to-peak, the range of voltages used in the research. The normal-state attenuation was found to be in reasonable agreement with the Pippard free-electron theory. The ql dependence, where q is the ultrasound wave number, of the zero-field attenuation in the [0001] and [$\bar{1}2\bar{1}0$] directions showed significant deviation from the theory in the region $ql \gg 1$. The attenuation in transverse magnetic field as a function H^{-1} was in qualitative agreement with free electron calculations for $\vec{q}||[0001]$ and $[\bar{1}2\bar{1}0]$, but was anomalous for $\vec{q}||[10\bar{1}0]$. The infinite field limit was approached as H^{-2} for all three directions in agreement with the theory. The ql results were separated into an impurity contribution and a phonon contribution using Mattheisen's rule. The impurity contribution was anisotropic. The phonon contribution obeyed a power law, $ql \propto_{ph}^{a} T^{-b}$, where $b = 3.6 \pm 0.1$ for both directions. The superconducting-state measurements showed that α_s/α_n, the ratio of the superconducting-state attenuation to the normal-state attenuation, dropped faster with decreasing temperature in the temperature region just below the transition temperature than the prediction of the BCS theory. Longitudinal wave measurements in other pure superconductors have shown similar behavior. No frequency effects were observed for α_s/α_n vs T/T_c for propagation along the [0001] and [$12\bar{1}0$] directions. For $\vec{q}||[10\bar{1}0]$, α_s/α_n was frequency-dependent, dropping faster as T was lowered near T_c as the frequency became lower. The zero-temperature energy gaps, based on the low-temperature data, were $3.90 \pm 0.1\ kT_c$, $3.52 \pm 0.15\ kT_c$, and $3.70 \pm 0.20\ kT_c$ for propagation along the [0001], [$\bar{1}2\bar{1}0$], and [$10\bar{1}0$] directions respectively. (TSS) (Disser. Abstr.)

38974 METHOD OF CORRELATION FUNCTIONS IN THEORY OF SUPERCONDUCTIVITY. VI. CONSIDERATION OF CRYSTAL LATTICES. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Naturforsch., 23a: 1-10(Jan. 1968). (In German).

The formulation developed in previous papers are approximately extended to more realistic models of a metal. After a number of approximations and simplifications earlier results are obtained, but with the electronic mass replaced by the effective mass of the conduction electrons. Boundary conditions at the interface between two metals in electric contact are formulated and discussed with respect to their consequences. (auth)

38975 FLUCTUATIONS AND LAMBDA PHASE TRANSITION IN LIQUID HELIUM. Ferrell, R. A.; Menyhard, N.; Schmidt, H.; Schwabl, F.; Szepfalusy, P. (Univ. of Virginia, Charlottesville). Ann. Phys. (N. Y), 47: 565-613(May 1968).

A general dynamical scaling theory of phase transitions is established by exploiting the absence of a characteristic length in an extended system at its phase transition. This similarity property imposes strong constraints on the frequency and wave-number dependence of the fluctuation spectrum and leads to unambiguous predictions concerning the critical properties. The theory is worked out in detail for the lambda transition of liquid helium, as a prototype. The fluctuations resulting from density waves at low temperature and from both first and second sound at higher temperatures, are closely examined. The connection between the divergent fluctuations in the second sound modes (as the temperature T approaches the lambda temperature T_λ) and the critical variation of the damping coefficients is established. The critical temperature dependences of the thermal conductivity of He(I) and the damping of first and second sound in He(II) are predicted to be essentially $(T - T_\lambda)^{-\frac{1}{3}}$, $(T_\lambda - T)^{-1}$, and $(T_\lambda - T)^{-\frac{1}{3}}$. (There occur also logarithmic factors.) Recent experimental measurements of the first and second of these give quantitative verification of the theory. In addition to the temperature dependence, the dynamical scaling theory does not employ any adjustable parameter and consequently also predicts the absolute magnitude of these quantities. Although this is a less conclusive check on the theory, the agreement is also satisfactory. (auth)

38976 EFFECT OF IMPURITIES ON SUPERCONDUCTIVITY-LIKE PHENOMENA IN ONE-DIMENSIONAL SYSTEMS. Zawadowski, A. (Central Inst. of Physics, Budapest). Zh. Eksp. Teor. Fiz., 54: 1429-38(May 1968). (In Russian).

Phase transitions of the superconducting type in a one-dimensional metal in the presence of impurities are investigated on the basis of the Bychkov, Gorkov, and Dzyaloshinski theory. A study of the contribution of "parquet" type diagrams in coordinate space shows that the highest power of the typical logarithmic term occurs at a certain space order of the elementary lattices. It is shown that due to a special cancellation of the phase shifts the impurities do not affect the transition temperature or excitation spectrum of any possible superconducting state in the quasi-classical approximation. (auth)

38977 EFFECT OF DISLOCATIONS ON SUPERCONDUCTIVITY. Zaitsev, R. O. Zh. Eksp. Teor. Fiz., 54: 1445-54(May 1968). (In Russian).

It is shown that a possible source of increase of the transition temperature of a superconductor with residual deformation may be oscillations of dislocation lines. The shift of the transition temperature is calculated for the simplest model. The upper critical field and residual resistance are determined on the basis of the model. The results obtained are compared with the experimental data and qualitative agreement is obtained. (auth)

38978 DESTRUCTION OF SUPERCONDUCTIVITY BY A CURRENT. Andreev, A. F. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz., 54: 1510-19(May 1968). (In Russian).

The structure of the intermediate state produced in a cylindrical superconducting sample under the action of an electric current which exceeds the critical value is elucidated. The interface between the normal and superconducting phases are paraboloids of rotation or cone-like surfaces depending on whether the Hall coefficient of the normal phase is large or small. The structure period and velocity of its motion along the sample axis are calculated. Corrections to critical current and resistance due to finiteness of the period are found. In very pure metals the superconducting region in the main part of the volume should have the shape of thin toroid-like threads. (auth)

38979 TUNNEL EFFECT IN LEAD UNDER PRESSURE. Zavaritskii, N. V.; Itskevich, E. S.; Voronovskii, A. N. (Inst. of High-Pressure Physics, Moscow. Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 211-15(Apr. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 271-7(Apr. 20, 1968).

The tunnel characteristics of lead under pressures up to 15 kbar at 1.3°K were investigated. The change in width of the gap in the energy spectrum of the electrons of the superconductor and the shift of the characteristic frequencies of the phonon spectra were determined. The results were used to verify the theory of superconductivity with strong coupling. (M.O.W.)

38980 HIGH FIELD CHARACTERISTICS OF $Nb_3(Al,Ge)$. Hartsough, L. D.; Zackey, V. F.; Parker, E. R. (Univ. of California, Berkeley). Appl. Phys. Lett., 13: 68-71(July 15, 1968). (UCRL-18101).

The J_c vs H curve for $Nb_3(Al_{0.8}Ge_{0.2})$ was measured and compared with that of the binary compound Nb_3Al. The Nb–Al–Ge alloy curve had a "peak" and its resistive critical magnetic field, $H_c(J = 0)$, was above 220 kG at 4.2°K. The composition of the ternary alloy was determined and found to be closer to the ideal 3:1 atomic ratio than that of the binary alloy. (auth)

38981 STABILITY OF THE FLUX-FLOW STATE IN SUPERCONDUCTING NbTi STRIPS. Kroeger, D. M.; Lubell, M. S. (Oak Ridge National Lab., Tenn.). Appl. Phys. Lett., 13: 63-5 (July 15, 1968).

Experiments concerning termination of the flux-flow state have been performed on bare NbTi strips. For these strips of low heat capacity, take-offs occurred at powers less than the maximum heat flux in nucleate boiling. It is concluded that take-off resulted from the simultaneous occurrence of a normal zone (caused by a local heat transfer fluctuation) and a current equal to or greater than the minimum propagating current. (auth)

38982 THE JOSEPHSON TUNNEL EFFECT IN ANISOTROPIC SUPERCONDUCTORS CONTAINING NONMAGNETIC IMPURITIES. Golub, A. A. (Inst. of Mathematics and Computation Center, Kishinev, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 61-2(July 1968).

Translated from Fiz. Tverd. Tela, 10: 84-6(Jan. 1968).

An expression is obtained for the dc Josephson current in a weakly anisotropic superconductor containing nonmagnetic impurities. The limiting cases of large and small impurity concentrations are investigated. (auth)

38983 CLUSTER EXPANSION FOR DEGENERATE BOSE FLUIDS. Morita, Tohru (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 39: 1100-20(May 1968).

The diagram expansions which are applicable to the degenerate Bose fluids at finite temperatures are derived within the framework of the canonical ensemble. They are natural extensions of the diagram expansions due to Bloch and Dominicis, Lee and Yang, and Montroll and Ward for the nondegenerate case. The formulation is performed as carefully as Kromminga and Bolsteri treated the Bose fluids at zero temperature. (auth)

38984 BERNOULLI POTENTIALS IN SUPERCONDUCTORS. Adkins, C. J.; Waldram, J. R. (Royal Society Mond Lab., Cambridge, Eng.). Phys. Rev. Lett., 21: 76-8(July 8, 1968).

It is shown that the variation of electric potential with current density in superconductors depends on the band structure of the metal concerned and, contrary to the prediction of the free-electron model, can take either sign. At absolute zero the size of the effect can be calculated from the band structure alone, but its temperature variation is connected with the dependence of the order parameter on current density, and is harder to obtain. (auth)

38985 THERMAL-CONDUCTIVITY MEASUREMENTS OF THE PROXIMITY EFFECT. Deutscher, G.; Lindenfeld, P.; McConnell, R. D. (Rutgers State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 21: 79-81(July 8, 1968).

The thermal conductivities K_{es} and K_{en} in the superconducting and normal states have been measured for four InBi films with Mn layers on each side. The slope of K_{es}/K_{en} vs t remains finite as $t \to 1$, as expected for gapless systems. The results indicate that there are states near the Fermi level, probably localized near the boundaries, which remain available at all temperatures. (auth)

38986 SOME FUNDAMENTALS OF LOW-TEMPERATURE CONDUCTORS AND SUPERCONDUCTORS. Olsen, J. L. Bull. Schweiz. Elektrotech. Ver., 57: 1019-26(Oct. 29, 1966). (In German).

The physics and some technological problems of cooled conductors and superconductors are described. The physical properties and significant problems of low-temperature normal conductors are completely different from those of superconductors. In both cases however, there are significant advantages in the reduction of resistance obtainable from refrigeration. The properties of conductors and superconductors under refrigeration are summarized and illustrated by graphs. (J.S.R.)

38987 EFFECT OF SURFACE STRAINS ON THE DIAMAGNETIC AND FIELD-RETAINING PROPERTIES OF TYPE-I HOLLOW CYLINDERS. Schweitzer, Donald G.; Adams, Peter D.; Nicolosi, Louis J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 220-3(July 22, 1968). (BNL-12037).

High-purity hollow cylinders of type-I superconductors in which the surface strains are minimal show order-of-magnitude decreases from the diamagnetic or field trapping properties described in present literature. The properties can be made to approach the predicted behavior when both surfaces are heavily strained. Both the diamagnetic and field-retaining properties are localized and can result in axial-field gradients in the void that exceed 10^3 Oe/cm. (auth)

38988 THERMODYNAMICS OF SUPERCONDUCTORS IN MAGNETIC FIELDS. Halpern, Otto (American Express Co., London). Acta Phys. Austr., 26: 231-42(1967).

The phenomenological theory of superconductors in a magnetic field is studied. The expression for the magnetic interaction energy is analyzed more closely. Finally, there is the relation discussed that exists between the specific heats of the two phases and the magnitude of the critical field. (auth)

38989 VORTEX-RING INTERACTIONS IN SUPERFLUID LIQUID HELIUM. Gamota, G. (Bell Telephone Labs., Murray Hill, N. J.); Sanders, T. M. Jr. Phys. Rev. Lett., 21: 200-2 (July 22, 1968).

Interactions between collimated monoenergetic beams of charged vortex rings were observed. The cross section for ring-ring interaction is approximately geometrical, consistent with a hydrodynamic interpretation. Capture of free ions by oppositely charged rings has also been observed. (auth)

38990 DECAY OF SUPERFLUID PERSISTENT CURRENTS. Kukich, G.; Henkel, R. P.; Reppy, J. D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 21: 197-200(July 22, 1968).

Superfluid persistent currents are observed to decay with a logarithmic time dependence for flow velocities near the critical velocity. The temperature dependence of the decay rate and the critical velocity obtained from the experiment are discussed in terms of a thermal activation picture. (auth)

38991 THE LOW-TEMPERATURE THERMAL EXPANSION BEHAVIOUR OF α-URANIUM. Hough, A.; Marples, J. A. C.; Mortimer, M. J.; Lee, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 27A: 222-3(July 1, 1968).

On quenching a sample of α-uranium into liquid helium from about 50°K, the transformation which occurs at 43°K and which is accompanied by an expansion, is suppressed. (auth)

38992 REDUCTION IN SPIN FLIP BREAKING OF COOPER PAIRS. Mihalisin, T. W. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Lett., 27A: 224-5(July 1, 1968).

The critical field of a superconductor/normal metal sandwich shows an anomalous increase at the Curie temperature of the normal film. This increase is interpreted in terms of the reduction in the spin exchange cross section in the ordered state. (auth)

38993 MICROWAVE-ASSISTED TUNNELING BETWEEN SUPERCONDUCTORS. Buettner, H.; Gerlach, E. (Batelle-Institut e.V., Frankfurt am Main). Phys. Lett., 27A: 226-7(July 1, 1968).

An argument is given against a modified current formula, recently used in the literature. (auth)

38994 SUPERCONDUCTIVITY IN DEGENERATE SEMICONDUCTORS. Appel, J. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Lett., 27A: 234-5(July 1, 1968).

For the Bogolyubov kernel describing the attractive interactions between electrons due to the exchange of acoustic phonons, the frequency factor Ω in the gap formula $\Delta = \Omega \exp(-1/\lambda)$ is found as a function of the electron concentration n or of the ratio E_F/ω_D (E_F = Fermi energy, ω_D = Debye energy). (auth)

38995 DIFFUSION COEFFICIENTS AND NUCLEAR MAGNETIC SUSCEPTIBILITY OF DILUTE ^{3}He-He II SOLUTIONS. Opfer, J. E.; Luszczynski, K.; Norberg, R. E. (Washington Univ., St. Louis). Phys. Rev., 172: 192-8(Aug. 5, 1968).

Measurements of the spin-diffusion coefficient and the nuclear magnetic susceptibility of ^{3}He-He(II) solutions of molar concentrations between 0.030 and 3.0% were made at temperatures above 0.4°K. The diffusion measurements show that the reciprocal of the spin-diffusion coefficient varies linearly with ^{3}He concentration. The constant term is identified as the reciprocal of the binary diffusion coefficient. Results for the binary diffusion coefficient are in agreement with the results of other measurements where comparisons are made. Between 0.8 and 1.6°K, the binary diffusion coefficient varies exponentially with the reciprocal of the temperature, in a manner consistent with the roton excitation energy of 8.65°K. The susceptibility exhibits only small deviations from perfect-Fermi-gas behavior. A calculation of the effect on the susceptibility of the direct interaction between ^{3}He quasiparticles made by utilizing an effective potential indicates that deviations from perfect-Fermi-gas behavior are small. There is reasonably good agreement between the measured and the calculated temperature dependence of the susceptibility. (auth)

38996 CRITICAL FLUCTUATION OF THE ORDER PARAMETER IN TYPE-II SUPERCONDUCTORS. Maki, Kazumi (Kyoto Univ.). Prog. Theor. Phys. (Kyoto), 39: 897-906(Apr. 1968).

The effect of the critical fluctuation (i.e., the thermodynamical fluctuation) of the order parameter in dirty type-II superconductors in a magnetic field H slightly above the upper critical field was studied. It was found that the fluctuation gives rise to a singular contribution to various transport coefficients, which diverge like $(H-H_{c2})^{-\frac{1}{2}}$. It is shown that in the usual dirty superconductor (say, with the electronic mean free path $l \sim 100$ Å), these effects will probably be unaccessible experimentally, because of the smallness of the coefficient in front of the singular terms. However, in extremely dirty superconductors (say with $l \sim$ Å), significant modifications of the transport properties due to the fluctuation may be expected. (auth)

38997 INTERACTION OF VORTEX FILAMENTS IN SUPERCONDUCTORS OF THE SECOND KIND WITH THE ELASTIC

DEFORMATION FIELD. Galaiko, V. P. (Kharkov State Univ.). JETP Lett. (USSR) (Engl. Transl.), 7: 230-3(Apr. 20, 1968).
Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 294-8(Apr. 20, 1968).

The interaction of vortices with the elastic field is determined in part by the magnetostatic interaction which results from the contribution of the magnetic and kinetic energies of the superconducting condensate to the pressure in the mixed state of a deformed superconductor. A calculation of this interaction which is linear in the deformation is made from considerations of the change in energy of the vortex lattice under the influence of the elastic field. Equations are given which determine the force acting on the vortex filament in the elastic field. (J.H.R.)

38998 ELECTRON TUNNELING INTO AMORPHOUS SUPERCONDUCTORS. Minnigerode, G. v.; Rothenberg, J. (Univ., Goettingen, Ger.). Z. Phys., 213: 397-410(1968). (In German).

Superconducting disordered and amorphous films of Bi, Ga, and Al are studied by the tunneling technique. The values of the reduced energy gap $2\Delta/kT_c$ (4.56 in amorphous Bi, 4.52 in amorphous Ga, 4.15 in amorphous Sn, and 3.72 in amorphous Al) indicate a very strong coupling in some amorphous superconductors. An increase of the tunneling resistance by crystallization of the amorphous Ga-films is interpreted as a decrease in the concentration of free electrons. The influence of the high film resistance on the measured slope of the tunneling curves is observed as long as both films or one of them are normal. (auth)

38999 INSULATION FOR SUPER MAGNET. Cryog. Eng. News, 3: No. 7, 24-6(July 1968).

The use of glass-filled tetrafluoroethylene skived tape for insulating the superconducting magnet coils of the ANL 12-ft bubble chamber is described. (W.H.K.)

39000 SUPERCONDUCTIVE RECTIFICATION AND ITS USE FOR FLUX PUMPING. Buchhold, T. A. (General Electric Co., Schenectady, N. Y.). pp 529-38 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967.
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

In 1964 the author published a description of a feasibility model (3 watts power output) of a superconductive power supply for large dc superconducting currents using a rectification principle. In this concept, which is called a "Flux Pump," small ac currents are conducted to low temperature, there transformed into large ac currents and then, using superconducting cryotrons, rectified into dc. Since conventional rectifying circuits using cryotrons alone do not work suitably, saturable reactors had to be added. Subsequent work has resulted in significant progress. Therefore, a more detailed and up to date description of the circuit operation is given and results obtained are summarized. Included is an explanation why conventional circuits using only cryotrons are not suitable. Two new flux pump models were built: one for 1000 amps and a second for 600 amps which has a dc power output of 18 watts. The space required was no larger than that for the original 3 watt model. This power density improvement by a factor of 6 was achieved by better optimization of component design and by a somewhat different design of the power cryotron. The 18 watt flux pump was operated successfully in energizing a 100,000 gauss coil with an energy content of about 27,000 joules. This coil was described by M. G. Benz at the meeting of the American Physical Society in New York, January, 1966. To the author's knowledge, this tested coil is the largest energized with a flux pump. It was shown that the coils could be charged and also discharged outside the dewar by operating the flux pump in reverse. If the flux pump is switched off after the coil is energized, the current continues as a permanent current. The flux pump has no moving parts. If a need is identified, it appears entirely practical to build flux pumps in the kW region for many thousands of amps. (auth)

39001 SUPERCONDUCTING DEVICES. Flynn, T. M. (National Bureau of Standards, Boulder, Colo.); Timmerhaus, K. D. pp 459-90 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967.
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

Superconductors may be treated as engineering materials having three unusual properties: (1) a transition occurs between two different states which depends upon external parameters, (2) zero resistivity is exhibited at zero frequency, and (3) perfect diamagnetism is exhibited in that state. This paper views superconductors in this way, as engineering materials, and examines applications of these properties. Examples include applications of superconductors to thermometry, bolometry, level gauging, rectifiers, magnets (briefly), bearings, motors, electron microscope lenses, and a helium pump. (auth)

39002 APPLICATIONS OF LIQUID HELIUM IN ELECTROMAGNETIC TECHNOLOGY. Weil, L. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). pp 449-58 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967. (In French).
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

Applications in three different fields are discussed. These include: Direct Current: Superconducting coils are used in science (general physics, bubble chambers, plasma physics) and in technology (MHD, thermonuclear fusion). Coils made of pure metals, cooled down to liquid helium temperatures, are in some cases competitive for producing high magnetic fields. Low frequency: Transformers, generators, motors, and rectifiers have been made with superconducting wires. The flux-pump is a particular type of generator. Transformers have been suggested, made of pure metal (copper for instance). High Frequency: Superconducting cavities have been used in transmitters and are common with masers. The linear accelerator is another promising device for use of liquid helium. Several switching devices should be added; a typical one is superconducting memories for computers. (auth)

39003 ARRANGEMENT FOR IRRADIATION IN A REACTOR CORE AT 20°K. Conte, R. R. (CEA, Fontenay-aux-Roses, France). pp 395-401 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967. (In French).
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

An arrangement is described for irradiation in a swimming pool reactor connected to an independent cryogenerator of small size and permitting irradiation with a power of 100 W at 20°K. (auth)

39004 HELIUM COOLED LIQUID HYDROGEN TARGET. Roubeau, P. M.; Der Nigohossian, G. (CEN de Saclay, Gif-sur-Yvette, France). pp 383-8 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967.
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

A liquid hydrogen target 2 cm in diameter and 5 cm long has been built. Its geometry lets a free access for the entering beam and an available 300° conical free space around the outgoing beam. This target is kept cold by circulating liquid helium at a rate of 3 liters per day. Initial cooling and condensation of hydrogen require about 0.5 liters. The whole hydrogen used (30 liters of gas NTP, i.e., 3 grams) is confined in a closed space consisting of: (1) the target useful volume where the liquid is allowed to condense; (2) a connecting tubing; and (3) a container where nearly all the hydrogen collects back as a gas when the circulation of cooling helium is discontinued. The advantages of such a target, as far as safety is concerned, are evident. (auth)

39005 LIQUID HELIUM TECHNOLOGY. Proceedings of the International Institute of Refrigeration, Commission 1, Boulder (U.S.A.), 1966. Pure and Applied Cryogenics, Volume 6. New York, Pergamon Press, Inc., 1967. 558p. $14.50. (In English and French). (CONF-660628).

Separate abstracts were prepared for 7 of the included sections. (M.O.W.)

For abstracts of individual sections see: 39000–39004, 39006, and 39007.

39006 AUTOMATIC SUPERCONDUCTING FLUX PUMP. Laquer, H. L.; Carroll, K. J.; Hammel, E. F. (Los Alamos Scientific Lab., N. Mex.). pp 539-44 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967.
From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

When two externally powered superconducting solenoids are connected in parallel, no net flux can enter the system until one of the solenoids becomes normal. By suitable relative sizing of the solenoids, one of them can be made to switch automatically so as to trap any desired amount of flux in the other. It is never necessary to apply an external current more than twice as large as the switching current, when the system design is optimum. Experiments with lead, solder, mercury and Nb–Zr solenoids also indicate the possibility of pulsing the desired fluxes into the system from a low voltage condenser bank or through a low-temperature transformer which eliminates the need for expensive high-current power supplies and for heavy current leads into the liquid helium. (auth)

39007 SUPERCONDUCTING DYNAMO AND SOLENOID COMBINATION OPERATING AT HIGH-CURRENT LEVEL. Van Houwelingen, D.; Luiten, A. L.; Volger, J. (Philips Research Labs., Eindhoven, Netherlands). pp 545-53 of Liquid Helium Technology. New York, Pergamon Press, Inc., 1967.

From International Inst. of Refrigeration Commission I Meeting, Boulder, Colo. See CONF-660628.

The progress in superconducting dynamos has lead to the development of a high current type having small dimensions and a simple construction for use in the kA region. Its electrical characteristics will be presented and the experimental and technical applications are discussed. The feasibility of a dynamo-solenoid combination has been proven. In a 70 mm bore solenoid wound with 49 stranded Nb–Zr cable, a field of 35 kG was measured in the center when the solenoid was energized by a persisting current of 1400 A generated by the dynamo within 25 minutes. (auth)

39008 MOBILITY OF POSITIVE AND NEGATIVE CHARGES IN ^{3}He AT THE CRITICAL POINT. Cantelli, R. (CNEN, Frascati, Italy); Modena, I.; Ricci, F. P. Phys. Rev., 171: 236-42 (July 5, 1968).

Measurements of the mobility of positive and negative charges in the ^{3}He critical region are reported. The experimental data show that for the two probes there is a definite lowering of the mobility at the critical point. However, within the limits of the critical point approach ($\Delta T/T_c \cong 6 \times 10^{-4}$; $\Delta p/p_c \cong 3 \times 10^{-5}$), no evidence of dramatic decrease in the mobility is observed. The decrease in the mobility is ≈30% for either probe; however, the influence of the critical phenomena on the shape of the mobility curve differs for the two probes probably because the positive and negative carriers differ in their effective radius. Some indication of the correct value of the ^{3}He critical temperature is also reported. (auth)

39009 EFFECT OF THE GRAVITATIONAL FIELD ON THE SUPERFLUID TRANSITION IN ^{4}He. Ahlers, Guenter (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 171: 275-82 (July 5, 1968).

It is shown experimentally that in a liquid helium sample of finite height, He II and He I coexist in thermodynamic equilibrium over a finite temperature range. This is contrary to a recent theoretical prediction. Observations made by noting the position of the boundary between the phases of high and low thermal conductivity as a function of temperature are quantitatively confirmed by high-resolution heat-capacity measurements near the transition region. The rate of movement with temperature of the interface between the two phases yields a slope for the transition line of 113.9 ± 4.6 atm/°K at saturated vapor pressure, in quantitative agreement with recent direct measurements. (auth)

39010 SPECIFIC HEAT OF A SPHERICAL TYPE-II SUPERCONDUCTOR. Zoller, Paul; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Rev., 172: 390-2(Aug. 10, 1968).

Specific-heat measurements on a spherical 7.05 wt % Pb–In alloy [type-II superconductor with $\kappa(T_c) = 0.72$] are discussed, with special emphasis on the difference in the effect of irreversibility on the determination of Maki's parameters κ_1 and κ_2 in calorimetric and magnetization measurements. Evidence is presented to show that κ_1 can be extracted reliably from specific-heat measurements even in the presence of severe irreversibility. $\kappa_1(T)/\kappa_1(T_c)$ showed a much stronger temperature dependence than that predicted by current theories for the case of noninfinite mean free path of the electrons. (auth)

39011 EXCESS CURRENTS IN SUPERCONDUCTING TUNNEL JUNCTIONS. Rowell, J. M.; Feldmann, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 172: 393-401(Aug. 10, 1968).

The excess currents that flow for $V < \Delta_1 + \Delta_2$ in two superconductor (S_1–I–S_2) tunnel junctions were studied. The features of interest are "multiparticle" tunneling, which is observed as a current increase at Δ_1 and Δ_2, and the subharmonic effects, which occur at $2\Delta/n$ when $\Delta_1 = \Delta_2$. Strong evidence is presented that subharmonic junctions contain metallic shorts, and it is shown that the $2\Delta/n$ series can be observed even in the absence of single-particle tunneling. By extending the study to asymmetrical junctions ($\Delta_1 \neq \Delta_2$) it is concluded that at present there is no satisfactory explanation of the subharmonic effects. (auth)

39012 LOW-TEMPERATURE AMPLITUDE-INDEPENDENT LONGITUDINAL ULTRASONIC ATTENUATION IN NORMAL LEAD. Fate, W. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 172: 402-12(Aug. 10, 1968).

The amplitude-independent normal-state attenuation of longitudinal ultrasound propagating in the [001] crystallographic direction in single-crystal lead was investigated using the pulse-echo method at frequencies between 10 and 210 MHz in the temperature range 1 to 8°K. A method for the detection of amplitude-dependent effects is presented; the work was limited to lightly cold-worked high-purity lead and well-annealed tin- and thallium-doped lead, where the amplitude independence of the results was experimentally demonstrated. A method for the evaluation of the electron mean free path from normal-state attenuation data is presented; the electron mean free path was evaluated for the specimens used in the experiment. The phonon-limited mean free path was found to be proportional to T^{-a} with $a = 4.02 \pm 0.05$. Below 4.2°K, relative phonon-limited mean-free-path values derived from the acoustic data agree closely with the resistivity data of Van den Berg, but above 7.2°K the acoustic and resistivity results differ. The ql and frequency dependence of the electronic attenuation is in good agreement with the free-electron calculations of Pippard, and the magnitude of the Sommerfeld-Wilson deformation-potential constant, as derived from the present data, is $|C| = (1.63 \pm 0.25)$ eV. In the low-ql limit, the magnetic field dependence of the electronic attenuation is not in agreement with results based on the free-electron model, nor is it consistent with the empirical behavior of the zero-field attenuation. The data do not support the electron-damped dislocation mechanism proposed by Mason to account for the anomalous superconducting-to-normal electronic-attenuation ratio that has been reported for lead. The implications of the present results as applied to Mason's theory are briefly discussed. (auth)

39013 AMPLITUDE-INDEPENDENT LONGITUDINAL ULTRASONIC ATTENUATION IN SUPERCONDUCTING LEAD. Fate, W. A.; Shaw, R. W.; Salinger, G. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 172: 413-23(Aug. 10, 1968).

The amplitude-independent attenuation of longitudinal ultrasound propagating in the [001] crystallographic direction in single-crystal superconducting lead was investigated, using the pulse-echo method, at frequencies between 10 and 210 MHz. Work was limited to lightly cold-worked high-purity lead and well-annealed tin- and thallium-doped lead where the amplitude independence of the results was experimentally demonstrated. The electron mean free path was evaluated for the specimens used in the experiment, and numerical data on the superconducting-to-normal electronic-attenuation ratio for well-characterized specimens are given for reduced temperatures greater than 0.6 where the data retain sufficient accuracy to be useful. The attenuation ratio derived from the measurements generally depends both on the ultrasonic frequency and impurity concentration, in disagreement with the prediction of the BCS theory. No unique value of the superconducting energy gap can be derived from the data using that theory. The decrease in the attenuation ratio near the transition is too rapid to be consistent with the BCS prediction. For reduced temperatures less than about 0.5 (depending on frequency and impurity concentration), the experimentally determined attenuation ratio decreases less rapidly that the BCS prediction. In pure deformed lead at temperatures where the mean free path is phonon-limited, the attenuation ratio is frequency-dependent and departs from BCS most strongly for the lowest ultrasonic frequencies. This result is to be compared with recent results reported by Deaton for pure, well-annealed lead, where departures from BCS were found to be most pronounced at the highest ultrasonic frequencies. When the electron mean free path was impurity-dominated, the attenuation ratio was found to be nearly frequency-independent in the frequency range studied, but is dependent on impurity concentration. The data agree most closely with the BCS prediction for high-impurity concentrations. The frequency dependence of the electronic attenuation in the normal and superconducting states is in qualitative agreement with calculations of the electronic thermal conductivity, which show that the phonon-limited electron mean free path in the superconducting state is less than the corresponding free path in the normal state. An attempt is made to interpret the data semiquantitatively using this idea, and numerical estimates of the superconducting-to-normal ratio of an effective (energy-independent) phonon-limited free path are given in the reduced temperature interval $0.6 \leq t \leq 1.00$. The mean-free-path analysis reproduces the main qualitative features exhibited by the data just below the transition, but fails to quantitatively explain some of the less prominent features of the data in this temperature range. For reduced temperatures less than about 0.5, the mean-free-path mechanism is incapable of explaining the behavior of the observed attenuation ratio. The results of the present experiment are briefly compared with results recently reported by others. (auth)

39014 LONGITUDINAL ULTRASONIC ATTENUATION IN PURE STRONG-COUPLING SUPERCONDUCTORS. II. Woo, James W. F. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 172: 423-4(Aug. 10, 1968).

Previous work on low-frequency longitudinal ultrasonic attenuation in pure strong-coupling superconductors is extended to all

values of ql (l = electron mean free path, q = phonon wave number). The result differs from that obtained for impurity scattering because vertex corrections are unimportant in the present problem. Numerical calculations of the reduced attenuation were performed for various values of q. (auth)

39015 SUPERCONDUCTING TRANSITION TEMPERATURES OF LEAD–THALLIUM ALLOYS. Nembach, Eckhard (Univ. of California, Berkeley). Phys. Rev., 172: 425-6(Aug. 10, 1968). (UCRL–18090).

T. Claeson's measurements of superconducting transition temperatures T_c of lead–thallium alloys have been repeated in the composition range 47 to 53 at. % Tl. In contrast to Claeson's findings, no dip in the T_c versus composition plot has been found. The exceptional behavior of Claeson's specimens with 49 to 50 at. % Tl seems to be due to sample inhomogeneity. (auth)

39016 INTRINSIC RESISTIVE TRANSITION IN THIN SUPERCONDUCTING WIRES DRIVEN FROM CURRENT SOURCES. McCumber, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., 172: 427-9(Aug. 10, 1968).

The Langer–Ambegaokar theory of dissipative fluctuations in narrow superconducting channels for T near T_c is extended to systems driven from current sources, with results identical to those previously obtained by Langer and Ambegaokar for voltage sources. (auth)

39017 CRITICAL-FIELD CURVES FOR GAPLESS SUPERCONDUCTORS. Decker, W. R.; Finnemore, D. K. (Ames Lab., Iowa). Phys. Rev., 172: 430-6(Aug. 10, 1968). (IS–1784).

Superconducting critical-field curves have been measured for pure Th and Th–Gd alloys at magnetic-impurity concentrations up to 60% of the critical concentration required to completely quench superconductivity. These samples all show a Meissner effect and type-I magnetic transitions reversible to at least 1% of H_c. The Abrikosov–Gor'kov theory has been used to make detailed calculations of the critical-field curves over the entire temperature range, and of lifetime broadening up to $\Gamma/\Delta(0,\Gamma) = 1$. Theory and experiment agree to an accuracy of better than 0.5%. (auth)

39018 MIXED STATE IN SUPERCONDUCTING THIN FILMS. Harper, F. E.; Tinkham, M. (Univ. of California, Berkeley). Phys. Rev., 172: 441-50(Aug. 10, 1968).

Critical magnetic fields of superconducting vacuum-evaporated tin films were measured for all angles θ between the magnetic field and the film surface at temperatures from 0.4 T_c to T_c. The experimental results were found to be consistent with Ginzburg–Landau theory provided that the original theory was modified to account for the extended temperature range and the nonlocal nature of superconducting electrodynamics. Measurements of the temperature dependence of the parallel and perpendicular critical fields supported the extensions of Ginzburg–Landau theory developed, most notably, by Maki and de Gennes. The angular dependence of the critical field for $0 < \theta < \frac{1}{2}\pi$ at different temperatures was found to be in agreement with Tinkham's original formula for several sufficiently thin films, $d \ll \xi_T$; a detailed derivation of that formula is given here, with discussion of its range of validity. For thicker films the corrections found by Yamafuji et al., were necessary to obtain agreement with the data. The critical fields were carefully measured for $\theta \approx 0$, and evidence of surface superconductivity was found in the thickest film studied, but not in thinner films. This is consistent with the numerical calculations of St. James and de Gennes. (auth)

39019 HIGH-FREQUENCY SOUND ABSORPTION IN SUPERCONDUCTORS. Snow, Joel Alan (Washington Univ., St. Louis). Phys. Rev., 172: 455-66(Aug. 10, 1968).

Theoretical and numerical results for the attenuation of high-frequency sound waves in superconductors are presented. Explicit calculations are given for the attenuation of longitudinal sound waves with wave-lengths both large and small compared with the electron mean free path in pure superconductors and in superconductors containing magnetic impurities. Extensions to more general situations are discussed. The contribution due to the disruption of Cooper pairs by phonons is examined as a function of impurity concentration. (auth)

39020 THEORY OF SUPERCONDUCTORS WITH OVERLAPPING BANDS IN THE PRESENCE OF NONMAGNETIC IMPURITIES. Chow, W. S. (Univ. of Cincinnati). Phys. Rev., 172: 467-75(Aug. 10, 1968).

The two-band model proposed by Suhl, Matthias, and Walker (SMW) for the superconducting state of pure transition metals is extended to the transition metals in the presence of nonmagnetic impurities. Both the interband and intraband impurity scattering are included in the formulation of the extended model. Two limiting cases of the extended model, namely, the strong intraband phonon-coupling limit and the strong interband phonon-coupling limit, are studied in detail. The basic features of the two limiting cases agree with those of the SMW model. It is found that, in the case of the strong intraband phonon-coupling limit, the lower one of the two transition temperatures is raised from that of the SMW model by the interband impurity scattering, and, in the case of the strong interband phonon-coupling limit, the transition temperature is either raised or lowered from that of the SMW model, depending on whether the interband impurity scattering or the intraband impurity scattering is stronger. (auth)

39021 SUPERCONDUCTIVITY IN SIMPLE METALS. Carbotte, J. P. (McGill Univ., Montreal); Dynes, R. C. Phys. Rev., 172: 476-84(Aug. 10, 1968).

An attempt to calculate directly from normal-state data the superconducting properties of a number of simple metals is reported. Information about the lattice vibrations is taken from a Born–von Kármán force-constant fit to the dispersion curves measured by means of inelastic neutron scattering. The matrix element of the electron–ion potential, for electrons scattering at the Fermi surface, is taken from pseudo-potential theory. From this information the electron–phonon part entering the Eliashberg gap equations is evaluated; the equations are then solved numerically to obtain the gap in the excitation spectrum. The calculated gap for Pb as well as for Al is in close agreement with experiment. For Na and K it is predicted that the transition temperature is certainly much less than 10^{-5} °K if, in fact, they superconduct at all. (auth)

39022 LIQUID ^{3}He. II. THREE-BODY CORRELATIONS AND THEIR CONTRIBUTION TO THE BINDING ENERGY. Oestgaard, E. (Princeton Univ., N. J.). Phys. Rev., 171: 248-62 (July 5, 1968).

The three-body contribution to the binding energy of liquid ^{3}He is calculated. The methods applied are those developed mainly by Bethe and collaborators for nuclear-matter calculations. Various two-body wave functions and off-the-energy-shell G-matrix elements are calculated, as in the effective interaction or representation of the G matrix in coordinate space. Three-body wave functions and three-body energy contributions are calculated or estimated by various methods. The calculations are repeated for several values of the input parameters which define the reference energy spectrum, and for several values of the relative momentum between the two interacting particles. The center-of-mass momentum is set equal to zero. The three-body contribution to the binding energy is found to be approximately −1°K per particle. This is, however, a rather uncertain value because the results are very sensitive to the values chosen for the average relative momentum in the calculations of the effective interaction off the energy shell. Also, in parts of the calculations only the S wave is included, and it is taken to represent the effect of the total wave function. Adding together the energy contribution from two-body and three-body correlations, we get a binding energy of approximately −1.5°K per particle for liquid ^{3}He, while the experimental value is −2.5°K per particle. (auth)

39023 ION MOBILITY DISCONTINUITIES IN SUPERFLUID HELIUM: A TEST OF THE HUANG–OLINTO THEORY. Goodstein, D. L.; Buontempo, U.; Cerdonio, M. (Univ., Rome). Phys. Rev., 171: 181-6(July 5, 1968).

A new method has been developed for making sensitive differential measurements of ion mobilities in liquid helium. Using this method, it has been possible to make a definitive test of the part of the Huang–Olinto theory intended to explain discontinuities in ion mobilities in superfluid helium. The theory has been found to be incorrect. (auth)

39024 PHONON–QUASIPARTICLE INTERACTIONS IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. II. PHONON BOLTZMANN EQUATION AND FIRST VISCOSITY. Baym, Gordon; Saam, W. F. (Univ. of Illinois, Urbana). Phys. Rev., 171: 172-8(July 5, 1968).

A phonon Boltzmann equation is constructed, taking into account previously calculated phonon–^{3}He scattering and absorption processes; when phonon–phonon interactions can be neglected this equation is exactly soluble. The first viscosity of solutions containing 1.3 and 5% molar concentrations of ^{3}He is calculated from this equation for $T \lesssim 0.6$°K. (auth)

39025 TWO-SORT SYSTEM OF FERMIONS AT LOW TEMPERATURES. Vavrukh, M. V. (Lvov State Univ.). Ukr. Fiz. Zh., 13: 733-42(May 1968). (In Russian).

The method of collective variables was used to investigate the equilibrium system of electrons and ions. The electronic spectrum of superconducting excitation was obtained. The effective potential of ions was found in adiabatic approximation. (auth)

39026 MOVEMENT OF THERMALIZED IONS IN LIQUID HELIUM IN EXTERNAL FIELDS. Reut, L. S.; Fisher, I. Z. (Odessa State Univ.). Ukr. Fiz. Zh., 13: 760-8(May 1968). (In Russian).

It is shown that, beginning with a temperature of 1°K and higher, the movement of ions in liquid He can be described by the equations of the Brownian movement theory because of big mass and size of the ions. A problem on the movement of an ion in given electric and magnetic fields is solved. Exact and closed expressions for Green's functions of the Fokker–Planck equation are obtained in the presence of an arbitrary spatial-uniform electric field. At the same time a constant-uniform magnetic field can be applied. The scope of the obtained solution application is discussed. (auth)

39027 SPIN–ORBIT COUPLING AND NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTING METALS. Hines, William Alonzo. Berkeley, Calif., Univ. of California, 1967. 74p.

Thesis.

The effect of spin-orbit coupling (through spin-reversing scattering) on the paramagnetic spin susceptibility of conduction electrons in a superconductor was studied. This was accomplished by investigating the nuclear magnetic resonance of two groups of superconducting samples. In the first group, the residual Knight shift was measured in three samples of pure lead particles with average particle dimensions of 120, 270, and 410 Å. Although small particle line broadening occurred, the nuclear resonance for the superconducting lead was observed and the residual shift was found to be a function of the particle size as was the case in previous work on pure tin. The effect of the increased spin–orbit coupling of lead with respect to tin was apparent, i.e., an electron in a lead particle had a higher probability of having its spin flipped in a collision with the boundary than an electron in a tin particle. In the second series of experiments, various concentrations of In, Sb, Pb and Bi impurities were added to tin and the residual shift was measured. For these samples, the electronic mean free path was controlled primarily by impurity concentration instead of particle size and the probability of an electron having its spin flipped in a collision with an impurity is determined by the spin–orbit coupling strength of the scattering center. It was found that a small amount (up to one atomic percent) of an impurity with weak spin–orbit coupling (e.g., In or Sb) has little effect on the residual shift, while the same amount of an impurity with strong spin–orbit coupling (e.g., Pb or Bi) increases the residual shift significantly. (Disser. Abstr.)

39028 IMPROVEMENTS IN OR RELATING TO REFRIGERATORS OPERATING AT VERY LOW TEMPERATURES. London, Heinz (to United Kingdom Atomic Energy Authority). British Patent 1,117,246. June 19, 1968. Filed Mar. 16, 1966.

A refrigerator capable of operating at a temperature below .06°K is described. In the device a superfluid solution of helium-3 in helium-4 is diluted reversibly by the addition of helium-4 through a superleak, thereby doing external work. Under these circumstances the solution is cooled, the temperature attained varying approximately as the two-thirds power of the change in helium-3 concentration. (TSS)

39029 FLUX TRAPPING IN A TYPE-II SUPERCONDUCTOR. Malseed, C.; Rachinger, W. A. (Monash Univ., Victoria, Australia). Scr. Met., 2: 121-2(Feb. 1968).

In the magnetization behavior of some type-II superconductors, a linear relationship is observed between the average induction of a sample in an increasing and the average remanent induction (or trapped flux) exhibited after reduction of the external field to zero. It is shown that such linear behavior is to be expected on the basis of the flux-pinning model developed by Irie and Yamafuji. The general usefulness of this model in giving an accurate representation of magnetization behavior is illustrated. The theory has been applied to experimental results with high-field, two-phase Pb–Bi alloys. (M.H.R.)

39030 COLLECTIVE FLUCTUATIONS OF THE ORDER PARAMETER IN SUPERCONDUCTING SURFACE SHEATH. Maki, Kazumi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1165-9(May 1968).

The effect of the collective fluctuations of the order parameter in the surface sheath region of dirty superconductors, is taken into account in calculating the electromagnetic response to microwaves. The complex conductivity is found to be strongly anisotropic, owing to these fluctuations, depending on the direction of the polarization vector of the microwave with respect to the static magnetic field. (auth)

Confinement and Heating of Plasma

Refer also to abstract 37775.

39031 (CONF-680805–7) PLASMA CONFINEMENT IN A TOROIDAL OCTUPOLE MAGNETIC FIELD. Forsen, H.; Kerst, D.; Lencioni, D.; Meade, D.; Mills, F.; Molvik, A.; Schmidt, J.; Sprott, J.; Symon, K. (Wisconsin Univ., Madison). [1968]. 26p. (C/N–24/C-1).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Plasma losses in the supports, hoops, and vacuum vessel walls were determined from the measurements of currents to particle collectors in an attempt to determine the intrinsic confinement properties of an octupole without supports. The observations indicate that the losses were not mainly on the supports but rather on the current-carrying hoops. Observations indicate that lf (≈100 Hz) phenomena are responsible since hf (10 kHz to 1 MHz) fluctuations were not consistent with the observations. The effect of obstacles similar to supports, static and magnetically guarded, insulated and conducting, was studied for subtle effects of confinement. (M.O.W.)

39032 (MATT-Trans-59) STUDY OF PLASMA COMPRESSION BY MEANS OF REFLECTION OF SUPERHIGH-FREQUENCY WAVES. Ipatov, V. A.; Kaganskii, M. G.; Kalmykov, S. G.; Ovsyannikov, V. A. Translated for Princeton Univ., N. J., from a Russian Report. 20p. Dep. CFSTI.

It is demonstrated that it is possible to investigate the compression of a plasma by an external magnetic field by using superhigh-frequency radiation range and detection equipment to the plasma. The measurements were taken on wavelengths of 4 mm and 8 mm. It is demonstrated that a sharp decrease in the concentration of the plasma takes place near the diaphragm in the Tuman device. The radius of the plasma column inside of which the concentration exceeds 1.7×10^{13} cm^{-3} decreases to 3 cm during compression (the radius of the diaphragm is 6 cm). The rates of displacement of the plasma layers with critical concentrations exceed the rates calculated from the condition of freezing the magnetic field in the plasma by 2 to 3 times. (auth)

39033 (REIC-TR-29) EQUILIBRIUM OF A HIGH BETA PLASMA IN A TOROIDAL MAGNETIC FIELD WITH A NON-PLANAR AXIS. Nagao, Shigeo; Sugita, Keiichiro; Chiba, Jiro; Watanabe, Hiroshige; Goto, Yukihiro; Kondo, Yoshiomi (Tohoku Univ., Sendai (Japan). Research Inst. of Electrical Communication). July 1968. 11p. Dep.

The optimum configuration for the equilibrium of a high-beta plasma was determined in the magnetic field with a non planar axis, which is a closed double helix. The beta value up to 100% is permitted under these conditions, where the average radius of the helix should be $R(n^2 + 1)^{-1}$, ($n^2 \gg 1$) and moreover the radius should have a small periodic component with twice the pitch. (auth)

39034 (TID-24513) FINAL REPORT OF AD HOC PANEL ON ASTRON PROGRAM. Feb. 1968. 33p. Dep. CFSTI.

39035 (UCID-15346) OBSERVATIONS OF PRECESSIONAL MOTION IN THE NEW ASTRON TANK IN THE HIGH VACUUM REGIME. Beal, J. W.; Lamb, W. A. S. (California Univ., Livermore. Lawrence Radiation Lab.). June 24, 1968. Contract W-7405-eng-48. 13p. Dep. CFSTI.

A set of measurements were made to explore some properties of high vacuum trapping in the new Astron vacuum chamber with trapping resistors in place. In particular it was desired to examine some aspects of the precessional motion in the high vacuum regime. The pressure in Astron was typically 6×10^{-7} torr. (auth)

39036 (UCRL-70675) PARAMETRIC VARIATION OF ASTRON VARIABLES. Weiss, P. B.; Brettschneider, M. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 29, 1967. 11p. (CONF-671132–2). Dep. CFSTI.

From Annual Meeting of the Division of Plasma Physics, Austin, Tex.

Several modifications and extensions of a one-dimensional computer code called RESIST, originally developed by Neil and Heckrotte have been undertaken. The purpose was to develop a computer model of the Astron with which "experiments" such as parametric variation of those variables of significance to the machine might be undertaken. In this code, the electrons are confined in a fixed plane between two conducting surfaces with a resistive plane placed appropriately. The calculation assumes the axial velocity of electrons is much less than c, and numerically integrates the Vlasov equation to give the particle distribution in $z - v_z$ phase space. The parameters recently studied have included the surface resistivity of the resistive wall, and the injection energy for several different injection currents. (M.O.W.)

39037 FIELD LINE TRAJECTORIES IN A SKORNYAKOV TRAP. Bickerton, R. J.; Lenamon, L. (Univ. of Texas, Austin). Contract AT(40-1)-3458. Nucl. Fusion, 8: 121-4(1968). (ORO-3458-10).

Skornykov has proposed a magnetic trap in which a spiral conductor connects diametrally opposite points on the inside surface of a superconducting sphere. He has argued that such a system will have nested toroidal magnetic surfaces and that these surfaces will have favorable stability properties both in terms of "average minimum B" and of "shear". Further he has maintained that the field distribution in such a trap can be closely reproduced by substituting an outer return spiral for the superconducting sphere and traps of this technically simpler type have been constructed. In this note the results of numerical calculations of the trajectories of magnetic field lines in such a two-spiral tran are discussed. One finds that there are always some field lines originating near the center of the system which leave it after one or two transits across the machine. Other lines are contained but trace out surfaces which are not topologically toroidal. Thus, traps of the two-spiral type will not contain plasma effectively. (auth)

39038 CLASSICAL AND ANOMALOUS DIFFUSION OF AN AFTERGLOW PLASMA. Geissler, Klaus H. (Environmental Science Services Administration, Boulder, Colo.). Phys. Rev., 171: 179-80(July 5, 1968).

The decay times of weakly ionized helium afterglow plasmas were measured for neutral gas pressures between 0.2 and 0.8 torr and magnetic field strengths from 0 to 800 G. Thus the transition from the field-free ambipolar diffusion to anomalous diffusion was covered. The plasma was confined by a cylindrical microwave cavity built in such a way that the end plates could be allowed to float electrostatically. With floating end plates we observed nearly classical diffusion, whereas anomalous diffusion was obtained when the end plates were kept at the same potential as the cylinder. (auth)

Diagnostics of Plasma

Refer also to abstract 38753.

39039 (CONF-680704-2) SOME ELECTRICAL PROPERTIES OF DENSE PLASMA. Paper SM-107/129. Alexeev, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). [1967]. 9p. Dep.

From Symposium on Magnetohydrodynamic Electrical Power Generation, Warsaw, Poland.

The considerable interest which appeared during the latest years concerning dense plasma, is in the first place caused by the possibility to produce a working media with high conductivity for MHD conversion and an aspiration to more profound understanding of the nature of conduction in the condensed state of matter. A peculiarity of such plasmas is the presence of quantum effects, caused by the overlapping of electron wave functions. (auth)

39040 (N-68-11059) ON THE UTILITY OF CONVENTIONAL TURBULENCE EXPERIMENTAL METHODS IN THE STUDY OF PLASMA FLUCTUATIONS. Serafini, John S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 21p. (NASA-TM-X-52371; CONF-671131-1). CFSTI.

From 20th Meeting of the Division of Fluid Dynamics, Bethlehem, Pa.

Experimental methods common in studies of ordinary fluid-dynamic turbulence are found to have significant application in the studies of plasma fluctuations. The low-frequency fluctuations, believed to have connection with problems of anomalous diffusion, are easily measured with presently available turbulence-measuring equipment. In particular, the space–time correlations of plasma fluctuations are useful in revealing convective effects. The rejection of various portions of the frequency spectra of the signals prior to their being correlated allows a further insight into the relationships between low-frequency peak portion and the remaining spectral portion of the fluctuations. The techniques and their application are discussed for the case of an annular Hall-current plasma accelerator. A slightly ionized argon discharge is subjected to an axial electric field and a radial magnetic field. The fluctuations are measured using Langmuir probes. In addition to the rms magnitude and amplitude spectra, the space–time correlations of the fluctuations have been made with a correlation analyzer having a response up to 500 kHz. The results are compared with those obtained in fluid-dynamic turbulence studies. (auth) (STAR)

39041 (N-68-17892) A MATHEMATICAL STUDY OF THE ELECTRON DECAY IN DIFFUSION AND RECOMBINATION CONTROLLED AFTERGLOWS: ANNALS OF PHYSICS. Frommhold, Lothar; Biondi, Manfred A. (Pittsburgh Univ., Pa. Space Research Coordination Center). Feb. 26, 1968. Contract DA-31-124-ARO(D)-G-518. 71p. (NASA-CR-93253; SRCC-71). CFSTI.

The continuity equation for electrons in a decaying plasma is solved numerically in three dimensions including a loss term quadratic in the electron density and an ambipolar diffusion term. The geometries investigated are the finite cylinder, the rectangular parallelepiped and some one-dimensional cases. The electron densities are averaged assuming weighting functions corresponding to various microwave probing field distributions and are therefore directly proportional to measured quantities obtained in microwave afterglow studies of recombination. The linear range of the computed reciprocal of the (averaged densities)$^{-1}$ versus time curves is determined and correction factors are derived which, if applied to the observations, yield the corrected recombination coefficients from the curves. The corrections derived in the two- and three-dimensional analyses are found to be significantly larger than those obtained in the one-dimensional analyses. Also, when considering plasma containers of different shapes but of the same fundamental diffusion length, a larger surface/volume ratio is found to be equivalent in effect to an increased diffusion coefficient in the predicted decays. (auth) (STAR)

39042 (N-68-21691) BOUNDARY CORRECTIONS FOR A THREE-COIL CONDUCTIVITY/VELOCITY PLASMA PROBE. Vendell, Edward W. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Apr. 1968. 32p. (NASA-TN-D-4538). CFSTI.

A three-coil plasma probe that measures both the electrical conductivity and velocity of laboratory plasmas having low magnetic Reynolds numbers has been developed and tested. As a first approximation, it was assumed that the plasma boundary was far from and much larger than the probe. The present work was undertaken to extend the previous theory by deriving factors that correct for the presence of cylindrical boundaries. As a check on this numerical work, several computed values were compared with electrical conductivity measured in cylinders of acid. Since the agreement was satisfactory, the boundary correction factors were used to reduce data taken as the probe was swept through an argon plasma generated by a constricted-arc wind tunnel. These resultant profiles represent local conductivity and velocity values for a free plasma jet having a cylindrical boundary. It was found that the raw data underestimates conductivity and overestimates velocity. (auth) (STAR)

39043 (NP-tr-1676) MICROWAVE PROBE INVESTIGATION OF PLASMA TURBULENCE IN A HIGH CURRENT TOROIDAL DISCHARGE. Larionov, M. M.; Rozhdestvenskii, V. V. Translated for Culham Lab., Abingdon, Eng., from Zh. Tekh. Fiz., 38: 279-84(1968). 12p. (CTO-498). Dep. CFSTI. UK.

Various effects arising from the interaction of microwave radiation with a turbulent plasma were investigated in Alpha (a high-current toroidal discharge stabilized by a weak longitudinal magnetic field and conducting wall). Fluctuations in the amplitude of the probe signal after passing through a layer of turbulent plasma were investigated. (M.O.W.)

39044 (SC-T-68-1524) DESCRIPTION OF TWO NEW PROBES FOR ENTHALPY AND PRESSURE MEASUREMENTS IN HIGH-TEMPERATURE GASES. Fischer-Schlemm, W. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt E. V., Stuttgart (West Germany)). Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from report DLR-FB-67-17. 47p. Dep. CFSTI.

A new enthalpy probe and a new enthalpy and pressure probe for measurements in high-temperature gases (4,000 to 15,000°K) are described. A jet, emerging from a plasma generator was measured with these probes. Mass and energy ratings were made. Additionally the results were compared with the results obtained from an enthalpy and pressure probe which is known since 1962. (auth)

39045 RADIAL AND LONGITUDINAL DISTRIBUTION OF CHARGE CARRIERS IN A DIFFUSION-CONTROLLED PLASMA. Chiplonkar, V. T.; Joshi, S. B.; (Inst. of Science, Bombay). Indian J. Pure Appl. Phys., 6: 190-1(1968).

Observations on the radial and the longitudinal distributions of charge carriers were made for a diffusion-controlled low-temperature active plasma. These show fairly good agreement with those expected theoretically. Radial variation of particle mobility, diffusion coefficient, and electron temperature were also measured. No evidence for negative ion formation is available. (auth)

39046 APPLICATION OF THE MICROWAVE FABRY–PEROT RESONATOR TO PLASMA DIAGNOSTICS. Chaffin, Roger James.

Madison, Wis., Univ. of Wisconsin, 1967. 159p.
Thesis.

A study of plasma diagnostics with a microwave Fabry–Perot resonator is presented in this dissertation. The study is both theoretical and experimental and includes a literature review. The theoretical study is based on an anisotropic perturbation theory which is derived in an appendix and also on a survey of the important electrical and mechanical parameters of the resonator which are also given. The electron density and collision frequency in a plasma may be found by observing the shift of the resonant frequency and the change in Q of the resonator when the plasma is energized. The theories for the measurement of electron density and collision frequency and their limitations are presented and experimentally verified. If the percent ionization is small the effective collision frequency may be considered as constant throughout the plasma region even though the electron density may vary with position. In this case it is found that the measurement of collision frequency is independent of the electron density profile. A theory for the measurement of the change in resonator Q through a measurement of the resonator transmission coefficient is presented and experimentally verified. This technique is shown to have certain advantages under noisy conditions. The diagnostics of an anisotropic plasma is examined both theoretically and experimentally and it is found that weak magnetic fields do not affect the plasma diagnostics, but stronger fields can have a significant effect which may be theoretically predicted. The diagnostics of time varying plasmas with a Fabry–Perot resonator were examined. It was found that for small low density plasma regions the time varying diagnostics are easily performed. However, for larger, more dense plasma regions such as might be found in a magnetic mirror machine, a more complicated system is required. Some of these systems were investigated experimentally and their characteristics are discussed. As a result of this study it was found that the microwave Fabry–Perot resonator is an accurate, reliable, highly sensitive, relatively economical diagnostic tool. (Diss. Abstr.)

39047 PLASMA PARAMETERS BY RF CONDUCTIVITY MEASUREMENTS. Chiplonkar, V. T.; Shah, R. G. (Inst. of Science, Bombay). Indian J. Pure Appl. Phys., 6: 128-9(Mar. 1968).

Particle density and collision frequency for a low temperature diffusion-controlled plasma have been measured by determining the rf conductivity and Langmuir single probe and have been shown to give consistent results. (auth)

39048 RADIAL ELECTRON DENSITY AND ENERGY DISTRIBUTION PROFILES IN A CYLINDRICAL STEADY-STATE ARGON PLASMA IN THE PRESENCE OF SMALL rf SIGNAL PERTURBATION. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Indian J. Pure Appl. Phys., 6: 130-2(Mar. 1968).

A perturbing rf voltage signal externally introduced into a diffusion-controlled low temperature cylindrical argon plasma has been shown to have an insignificant effect on the radial profiles for the electron density and energy as compared to those obtained in the absence of the signal. Agreement between the experimental and the Schottky radial particle density profiles is fairly good when the constant b in Schottky's expression $n_r = n_0 J_0(br)$ is determined for each condition by the probe measurements when it is located at the geometrical position of the wall. (auth)

39049 PARTICLE CONCENTRATION PROFILES IN LOW-TEMPERATURE DIFFUSION-CONTROLLED GAS-DISCHARGE PLASMA. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Indian J. Pure Appl. Phys., 6: 148-9(Mar. 1968).

Schottky's theory for radial density variation across a cross section of a longitudinally homogeneous plasma was confirmed over wide ranges of experimental parameters, assuming the particle density at the plasma boundary is nonzero on account of the formation of the sheath. (auth)

39050 QUANTUM THEORY OF PRESSURE BROADENING IN PLASMA. Tsuji, Akio; Urabe, Yukio; Narumi, Hajime (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 1079-81 (Apr. 1968).

The scattering matrix instead of the classical path approximation is used to formulate a theory of pressure broadening in plasma with quantum-mechanical consistency. (J.H.R.)

39051 A NEW METHOD FOR DETERMINATION OF PLASMA ELECTRON TEMPERATURE FROM THE CURRENT–VOLTAGE CHARACTERISTIC OF A FLOATING DOUBLE PROBE. Dote, Toshihiko (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 44: 119-27(May 1968). (In Japanese).

Eliminating a contradiction found in the calculation of the positive ion current in the existing theories, a more rigorous analysis of the current–voltage characteristic of a floating double probe has been developed, from which a new method for determination of the electron temperature has been derived. This method is very simple and makes it possible to estimate the electron temperature more correctly. (NSA of Japan)

39052 ELECTRICAL CONDUCTIVITY IN SEEDED NOBLE GAS PLASMAS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Brederlow, G.; Hodgson, R. T. (Institut fuer Plasmaphysik, Munich). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1277-84(July 1968).

Methods and results of measurements of the tensor conductivity and electron temperatures in argon–potassium and helium–potassium plasmas with elevated electron temperatures under MHD generator conditions are described. Electrode and wall effects that would make the measurements more difficult to interpret were eliminated. Calculations of W. Feneberg predict that the scalar electrical conductivity should drop slightly with increasing magnetic field strength. However, the measured effective scalar conductivity was less than the theoretically predicted value. The discrepancy is apparently due to instabilities. These instabilities were investigated. At current densities and field strength values at which instabilities were observed, the effective Hall coefficient was found to be nearly independent of the magnetic field strength. The measurements show that the efficiency of a noble gas MHD generator is adversely affected not only by the decrease of the scalar conductivity in a magnetic field, which was predicted by W. Feneberg, but also by the onset of instabilities. (auth)

39053 LASER DIAGNOSTICS OF THETA-PINCH PLASMAS. Yoseli, Morihiro; Maejima, Yoshiki; Ikeda, Nagayasu; Sugiura, Masaru; Tamaru, Takeshi. Kato, Kiyoe. Denki Shikensho Iho, 32: 299-308(1968). (In Japanese).

Plasma densities have been measured in a 200-kJ theta-pinch plasma by using a Mach–Zehnder interferometer with a light source of a ruby laser. The interferograms of plasma densities have been taken while conditions such as the time sequence, filling pressure and initial charging voltage of condensors are changed. The maximum plasma density is $(2 \text{ to } 3) \times 10^{17}/\text{cm}^3$ in case of air of filling pressure 200 μ Hg. This density is considered to be the highest of those of theta-pinch plasmas that have been obtained in Japan. (auth)

39054 PRESSURE PROFILE IN A STATIONARY, MAGNETIC-FIELD-STABILIZED HELIUM PLASMA OF HIGH DENSITY AND TEMPERATURE. Grassmann, P. H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 23a: 251-63(Feb. 1968). (In German).

The density and temperature in a stationary, magnetically stabilized He arc plasma are determined. The axial temperatures measured are between 200,000 and 400,000°K, depending on the discharge current. The electron densities are found to be $n_e = 1.5 \times 10^{16}$ cm^{-3}, the value being constant over the arc radius. These measurements yield very steep radial pressure gradients and axial pressures of up to 1 atm. The pressure profiles are dealt with quantitatively. It is shown that the pressure buildup is governed essentially by a thermomagnetic effect familiar in solid-state physics, namely the Nernst effect. The theory of this effect readily explains why the electron density is constant over the radius. (auth)

Kinetics of Plasma

Refer also to abstracts 38809, 38839, and 39052.

39055 (AD-664342) STUDY OF STABILITY OF HYDROMAGNETIC PLASMAS AND THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE BEHAVIOR OF IONIZED GASES IN A MAGNETIC FIELD UNDER SHOCK CONDITIONS. Final Report, June 1, 1963–May 31, 1967. Besse, A.; Bostick, W. H.; Deshmukh, A.; Emmert, G.; Farber, E. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Dec. 1967. Contract AF19(628)-2398. 56p. (SIT-P-207; AFCRL-67-0675). CFSTI.

Driver temperatures in excess of 25,000°K were attained for an arc-driven shock tube by utilizing a prestressed ceramic liner. Contamination and cooling of the driver gas by evaporated liner products were reduced. A laser interferometer was perfected for the study of strong ionizing shocks. Measurements on argon shocks allow detection of the passage of the shock front, determination of the length of the ionized gas sample and determination of the electron density in the ionized gas. Another diagnostic technique employed in the study of the ionized gas sample utilizes an electron beam. Electron scattering and spectroscopic analysis of the radiation permit determination of particle density and rotational and vibrational temperatures in the ionized gas. Plasma–magnetic field interfaces are studied in several geometries. Studies were performed on trajectories of parallel-to-B_0 plasma

vortices which travel in a magnetic field with a gradient. A plasma camera was developed for this type of vortex in a homogeneous magnetic field and data indicate the plasma vortex structure to be very complex. Schlieren instrumentation for perpendicular-to-B_0 was constructed to be used on a parallel-plate accelerator. (auth) (USGRDR)

39056 (AD-664585) A STUDY OF THE SOLUTIONS OF ONE-DIMENSIONAL VLASOV-POISSON EQUATIONS FOR HARMONIC TIME DEPENDENCE AND EXTERNAL POTENTIAL. Report No. Scientific-51. Tinhofer, Gettfried (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Oct. 30, 1967. Contract F61052-67-C-0014. 17p. (AFOSR-68-0226). CFSTI.

The behavior of the solutions of a simplified form of the system of Vlasov–Poisson equations is studied. An external disturbance function is intended to simulate a confining magnetic field. A condition for the existence of continuously differentiable solutions is derived which has the form of an integral relation between the Poisson function and its derivative. The two cases of a given spatial distribution and a given velocity distribution are considered. (auth) (USGRDR)

39057 (CEA-R-3450) STUDY OF A DECAYING HELIUM PLASMA HAVING A HIGH NEUTRAL PARTICLE DENSITY. Deloche, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 31p. (In French). Dep.

The effect of low-energy inelastic collisions between neutral particles on the population densities of excited molecules and the electron–ion recombination coefficient was investigated in a high-pressure decaying He plasma. The formalism of Bates (1962) was used, taking into account simultaneously collisional mechanisms with electrons, collisional mechanisms with neutrals and radiative processes. The variation of the population densities and electron–ion recombination coefficient with respect to the pressure is given for different values of electron density and temperature. These theoretical results indicate an effect of pressure large enough to be measured and allow one to define the most favorable experimental conditions. (auth)

39058 (CEA-R-3490) THEORETICAL STUDY OF PROPERTIES DUE TO THE CURVATURE IN THE TOROID SHAPE IN MAGNETOHYDRODYNAMICS. Adam, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1968. 68p. (In French). (EUR-3857). Dep.

Thesis.

A toroidal plasma centered around a closed Γ is considered. When the rotational transform $\Gamma/2\pi$ approaches an integer k, curvature effects are very important. When the rotational transform is created by current flowing in the plasma the coefficient a_k of the Fourier expansion of curvature $1/R(s)$ is not zero. One finds then that the influence of a_k is predominant and that it is possible to neglect all the other members of the series to study the neighborhood of the corresponding equilibrium singularity. By developing an adapted coordinate system it is thus possible to take into account curvature effects at the lowest order. Equilibrium study brings one to introduce an equilibrium parameter $\nu \leq 1$ characterizing curvature effects. It is shown that when ν is near 1 the more shear and $V''(\psi)$ quantities occuring in the stability criterion are important. Finally, the stability investigation shows that the larger the integer k the smaller the domain of stability, when $L/2\pi$ is near k. (auth)

39059 (CONF-670840-1) STUDY OF TORSIONAL ALFVEN WAVES IN INHOMOGENEOUS PLASMAS. Report No. 3-13. Schueller, P. G.; Mueller, G.; Aldinger, W.; Raeuchle, E.; Kaeppeler, H. J. (Technische Hochschule, Stuttgart (West Germany). Institut fuer Plasmaforschung). Aug. 1967. 17p. Dep.

From 2nd European Conference on Controlled Fusion and Plasma Physics, Stockholm, Sweden.

The propagation of torsional Alfvén waves in a current-carrying inhomogeneous hydrogen plasma was investigated. The plasma is generated by a longitudinal discharge in a glass tube. The maximum current is 4.2 kA. The tube is designed as a waveguide. The initial gas pressure is approximately 0.1 mm Hg. A quasi-stationary longitudinal magnetic field up to 5 kG is applied. The Alfvén waves were excited by a short current pulse over a secondary electrode (m = 0 mode), or a single loop coil (m = ±1 mode) and were detected by magnetic probes. The probe signals were Fourier-analyzed to obtain the dispersion relation. By this method, the dispersion curve was measured in a frequency range from 100 kc up to 1 Mc. The measured phase velocities are in the range of 10^7 cm/sec and the damping constant is about 10^{-1} cm. The inhomogeneity of the plasma density leads to nonuniform phase velocity and damping over the cross section of the plasma column. This is observed experimentally. In a current-carrying plasma, the inhomogeneity of the electron temperature causes a current convective instability which results in different damping constants for the m = +1 and m = −1 mode. An initially linearly polarized wave will therefore be transformed into an elliptically polarized wave. This behavior was confirmed in the experiment. The observed dispersion shows irregularities, which may be caused by a propagation of an additional wave with different propagation properties and the development of standing waves between the two probes which lead to interference effects. (auth)

39060 (CONF-670928-5) BREMSSTRAHLUNG OF A FULLY IONIZED PLASMA IN THE INFRARED. Bogen, P.; Rusbueldt, D. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). [nd]. 9p. Dep.

From Pulsed High-Density Plasmas Conference, Los Alamos, N. Mex.

The frequency dependence of the bremsstrahlung for $h\nu \ll kT$ and $\nu > 2\nu_p$ (where ν_p is the plasma frequency) was measured and compared with theory. Experiments were carried out on a theta pinch with the following data: $\tau/4 = 0.75$ μsec, $B_{max} = 45$ kG, $T \approx 10^{4\pm1}$K, $N_e \approx 3 \times 10^{17}$ cm^{-3}. The intensity between 0.25 μ and 25 μ has been measured with a time resolution of 20 nsec, using an InAs photodiode and a copper-doped germanium photoresistive detector in the infrared, and a photomultiplier in the visible and ultraviolet domains. It was verified that the emission signals observed side-on were at all times and for all wavelengths practically proportional to one another; shape differences observed end-on, resulted almost certainly from refractive index effects. The experiments confirm the theoretical prediction, that the Gaunt factor should vary by a factor two in the investigated wavelength domain. No influence of three-body encounters or nonthermal radiation has been detected. (auth)

39061 (N-68-11083) EFFECT OF AXIAL FLOW ON THE BEHAVIOR OF THE WALL-CONSTRICTED ARC. Stine, Howard A.; Watson, Velvin R.; Shepard, Charles E. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1964. 43p. (NASA-TM-X-54065; CONF-640925-2). CFSTI.

From 22nd Meeting of the Supersonic Tunnel Assoc. at the Von Karman Institute for Fluid Dynamics, Rhode-Saint-Genese, Belgium.

An experimental and theoretical study of the interaction between an electric arc and a coaxial flow of gas has been carried out in a range of size, enthalpy level, and pressure level where radiation heat loss is a noticeable portion of the total loss from the system. Numerical calculations have been performed and have been compared with earlier analytic calculations and also with the experimental results. Although differences in the detailed behavior of the gas flow-arc interaction are predicted by the two theoretical methods, the integrated behavior as deduced by either of the theoretical methods is essentially the same. Moreover, this integrated behavior is in substantial agreement with the experimental results, at least insofar as predictions of buildup of energy flux are concerned. (auth) (STAR)

39062 (N-68-11404) POWER TRANSFER TO ION CYCLOTRON WAVES IN A TWO ION SPECIES PLASMA. Sigman, Donald R.; Reinmann, John J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1967. 13p. (NASA-TM-X-1481). CFSTI.

Calculations were made on the efficiency of using a Stix coil to transfer power to waves near the ion cyclotron frequencies of a cold, collisionless plasma consisting of two ion species. The mass ratio m_b/m_a of the ion species was 2, and the frequency region near and between the cyclotron frequencies (Ω_{ia} and Ω_{ib}) of each ion species was investigated. For wave frequencies ω less than Ω_{ib}, only the usual ion cyclotron resonance absorption peak is obtained. For $\Omega_{ia} > \omega > \Omega_{ib}$, two absorption peaks are obtained. The additional peak corresponds to power absorbed by fast wave modes associated with the heavier species. The wave set up nearer the cyclotron frequency of the lighter ion Ω_{ia} is a left-polarized wave, and power is absorbed primarily by modes whose wavelengths, which are parallel to the static magnetic field, are near the wavelength of the Stix coil. The second absorption peak occurs at lower frequencies where the power is absorbed by the right-polarized fast wave modes associated with the heavier species. There is a sharp cutoff on the low-frequency side of this second absorption peak. (auth) (STAR)

39063 (N-68-12828) LOW-FREQUENCY COMPONENT ELECTRIC MICROFIELD DISTRIBUTIONS IN PLASMAS. Hooper, C. F. Jr. (Florida Univ., Gainesville. Dept. of Physics and Astronomy). [1967]. 25p. (NASA-CR-91295). CFSTI.

Low frequency component electric microfield distributions in a plasma are calculated at both a neutral and charged point. It is

shown that this calculation allows for the inclusion of all correlations to a high degree of accuracy. The theory is compared with the Holtsmark and Baranger–Mozer theories. A detailed analysis of all approximations is included, together with a Monte Carlo study. Numerical results are shown both graphically and in tabulated form. (auth) (STAR)

39064 (N-68-12880) ELECTRON CORRELATIONS IN PLASMA LINE BROADENING. Smith, Earl W. (Florida Univ., Gainesville. Dept. of Physics and Astronomy). [1967]. 33p. (NASA-CR-91284). CFSTI.

A method of including electron correlations in the relaxation theory for spectral line broadening plasmas is presented. The effect of these correlations in the relaxation theory is compared with the analogous results in the impact theory; specifically, it is shown that the impact parameter cutoff used in the impact theory constitutes a very good approximation to the effect of these correlations. (auth) (STAR)

39065 (N-68-13142) THEORETICAL AND EXPERIMENTAL STUDIES OF THE NATURE AND CHARACTERISTICS OF SPACE-RELATED PLASMA RESONANCE PHENOMENA. Semiannual Report, November 1, 1966–April 30, 1967. Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). May 1967. 38p. (NASA-CR-91335; SU-IPR-167; SAR-4). CFSTI.

In the theoretical studies, emphasis was placed on establishing the properties of cyclotron harmonic waves (CHW) propagation in a magnetoplasma with a spherical shell electron velocity distribution. The appropriate dispersion characteristics are discussed, and the results are compared with those for a cylindrical shell distribution. The results are considered significant in that an anisotropic, monoenergetic, velocity distribution will relax to a spherical shell if electron–neutron momentum transfer collisions occur; a modification and probable weakening of the strong instabilities associated with an anisotropic distribution will then occur. Equations are also derived to describe obliquely propagating modes in a magnetoplasma with an isotropic Maxwellian distribution. Experimental techniques are discussed for measuring oblique propagation (Maxwellian distribution) and perpendicular propagation (spherical shell distribution). The possibility of applying resonance rectification phenomenon to plasma diagnostics is mentioned. (STAR)

39066 (N-68-13516) PHYSICAL PROCESSES IN THE MAGNETOPLASMADYNAMIC ARC. Semiannual Report, March–September 1967. Lovberg, R. (California Univ., La Jolla, San Diego). Nov. 1967. 22p. (NASA-CR-91529; SAR-3). CFSTI.

A detailed investigation of the current spoke was made during this period. More compact Rogowski coils were developed and used to make more detailed measurements of spatial distributions of current and potential, and thus define the spoke structure more clearly. Plasma flow velocities were detected in the spoke with biased electric probes. These measurements indicate that the plasma is moving azimuthally with the spoke and that the spoke exhibits some internal structure. A magnetohydrodynamic model of the spoke is being developed. (STAR)

39067 (N-68-14559) ANALYSIS OF MPD ARCS WITH NON-EQUILIBRIUM IONIZATION. Seals, R. K. Jr.; Hassan, H. A. (North Carolina State Coll., Raleigh). Jan. 24, 1968. 8p. (NASA-CR-91685; CONF-680101-4). CFSTI.

From AIAA 6th Aerospace Sciences Meeting, New York.

A quasi one-dimensional analysis of the MPD arc which takes into consideration finite reate processes and allows for a variable area is presented. Starting from low subsonic velocities at the entrance, the governing equations are integrated through the transonic region into the supersonic region for an argon propellant at low mass flow rates. The results show that the electron temperature is well predicted by the theory; however, calculated velocities are roughly half the measured values. The current densities peak in the neighborhood of the cathode tip and they do not exhibit any unusual features in the transonic region. (auth) (STAR)

39068 (N-68-18703) ATTENUATION AND DISPERSION OF LONGITUDINAL WAVES IN VISCOUS, PARTLY IONIZED GASES. Kahn, David (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). Mar. 1968. 9p. (NASA-TM-X-1458). CFSTI.

The propagation of longitudinal waves in three-fluid, partly ionized gases is studied as a function of the collision and plasma-to-wave-frequency ratios. A collisional approach is taken with the full Boltzmann equations (together with Maxwell's equations) serving as the starting point, the intention being to describe wave dispersion and absorption in the collisional regime, and to include the viscous and heat conduction effects on the wave propagation from the beginning as an integral part of the theory. (auth) (STAR)

39069 (N-68-19082) KINETIC THEORY OF INHOMOGENEOUS SYSTEMS. Price, John C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1968. 66p. (NASA-TM-X-63131; X-641-68-89). CFSTI.

A theory is developed which treats the coupled equations of the various hierarchies as simultaneous equations in time. This scheme proceeds by successive approximations rather than a power series expansion in the small parameter. The theory is suitable for the derivation of equations for nonuniform and force driven systems. Examples are given for a plasma and a Boltzmann gas. (auth) (STAR)

39070 (N-68-19706) ELECTRICAL CONDUCTIVITY OF A COLLISIONLESS MAGNETOPLASMA IN A WEAKLY TURBULENT MAGNETIC FIELD. Newman, C. E.; Sturrock, P. A. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1968. 20p. (NASA-CR-93719; SU-IPR-227). CFSTI.

The behavior of test particles in the presence of uniform, parallel, and steady electric and magnetic fields in addition to a weakly turbulent magnetic field is studied. The quasi-linear approach is used to find a diffusion equation for the distribution function describing the test particles; the diffusion equation describes the pitch-angle scattering experienced by the test particles due to the random fluctuations of the magnetic field. In the weak-electric-field limit the equation is analyzed in detail and an expression for the electric conductivity in terms of the correlation tensor of the fluctuating field is found. Finally, for the case of a particular model of the turbulence and a Maxwellian distribution of test particles, an explicit formula for the conductivity is given. (auth) (STAR)

39071 (N-68-19962) FREQUENCY MULTIPLICATION IN HIGH-ENERGY ELECTRON BEAMS. Semiannual Progress Report, April 1–October 1, 1967. Getty, W. D.; Lomax, R. J.; Rowe, J. E. (Michigan Univ., Ann Arbor. Electron Physics Lab.). Feb. 1968. 17p. (NASA-CR-93743; SAPR-2). CFSTI.

Summaries are presented for high energy studies dealing with a relativistic electron beam device, beam–plasma interactions, and the time-dependent nonlinear analysis of electron beam–plasma interaction. Nonlinear Lagrangian analysis of beam–plasma systems is also reported, as is the harmonic current generation in a beam-plasma system. Studies of cyclotron harmonic instabilities deal with approximate dispersion equation, electron beam parameters, and experimental results. (STAR)

39072 (N-68-20825) WAVE INTERACTION IN NONRELATIVISTIC ELECTRON BEAM–PLASMA SYSTEMS. Otteni, Gerald A. (Case Inst. of Tech., Cleveland, Ohio). July 1967. Contract AF19(628)-1699. 179p. (NASA-CR-93962; A-53; AFCRL-67-0375; SR-17). CFSTI.

A theoretical model based on the linearization of the field equations and Maxwell's equations for wave interaction in a uniform plasma which is interpenetrated by a nonrelativistic electron beam is developed. The effects of electron–neutral and electron–ion collisions and temperatures of both the beam and plasma electrons are included and no quasi-static approximation is made for the electromagnetic field. An external dc magnetic field is assumed to act so that a general formulation is developed which is valid in the limit of small dc magnetic fields and in the limit as the field becomes very large. Graphs of the computer solutions are given for the propagation constants in a beam–plasma system for the cases of an unbounded system and for the TM wave solutions that may exist in an axisymmetric cylindrical system in which the finite beam interpenetrates an unbounded plasma. (auth) (STAR)

39073 (N-68-21096) RESPONSE OF A ONE-DIMENSIONAL VLASOV PLASMA TO EXTERNAL ELECTRIC FIELDS. Harding, Rollin C. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Mar. 1968. 39p. (NASA-CR-93977). CFSTI.

The response of a one-dimensional electron plasma confined by perfectly reflecting boundaries has been calculated numerically for several externally-maintained electric field configurations representing different physical situations. The electron distribution function is expanded in a Fourier–Hermite series. The external fields (of various wavenumbers and frequencies) are represented by equivalent charge density terms in Poisson's equation. In the first situation the external field is a standing wave oscillating at approximately the resonant frequency for the given wave number k_0. In the second situation the external source charge density is held constant and represents a small sinusoidal inhomogeneity in the ion background. In another calculation the inhomogeneity in the background charge density is varied slowly compared with the electron plasma frequency to simulate the field seen by electrons in the presence of an ion acoustic wave. In a

fourth situation the ion inhomogeneity is switched on suddenly with the electrons initially in a uniform equilibrium and eventually approaching an inhomogeneous equilibrium by Landau damping. (auth) (STAR)

39074 (N-68-21242) COAXIAL-FLOW STABILIZATION OF AN ALTERNATING-CURRENT PLASMA ARC. Lanzo, Chester D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1968. 11p. (NASA-TM-X-52424; CONF-680616-1). CFSTI.

From Conference on Fluid and Plasma Dynamics, Los Angeles, Calif.

Experimental results are presented for a coaxial-flow-stabilized, ac, 12- to 22-cps (12- to 22-Hz) electric arc. The arc is maintained along the centerline of an argon jet. Coflowing streams of either helium or nitrogen surround the central argon jet. The arc is stabilized by the flow field of the two gases. General characteristics of arc behavior are described for various operating conditions. Arc length is varied from 1 to 12 inches (2.54 to 30.5 cm). Photographs of the arc at maximum intensity are shown. (auth) (STAR)

39075 (N-68-21832) SHOCK-LIKE SOLUTIONS OF THE ELECTROSTATIC VLASOV EQUATION. Montgomery, David; Joyce, Glenn (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Apr. 1968. 32p. (NASA-CR-94137). CFSTI.

It is shown how to construct shock-like time-independent solutions of the electrostatic Vlasov and Poisson equations in one dimension. The positive ions are assumed to be at zero temperature. The electrostatic potential is assumed to increase monotonically through the shock from zero to a constant value. The most important feature of the solution is a population of trapped electrons in the shocked plasma. In contrast to time-dependent solutions based upon fluid equations, there is no upper limit on the amplitude of the shock. (auth) (STAR)

39076 (N-68-22854) AN EXPERIMENTAL INVESTIGATION OF SHOCK WAVES IN HIGHLY IONIZED HELIUM. Spencer, George L. (Case-Western Reserve Univ., Cleveland, Ohio). June 1966. 83p. (NASA-CR-94395; A-43). CFSTI.

An experimental investigation of shock waves moving through a highly ionized gas is reported. The shock waves are generated in an electromagnetic T tube. The ambient gas, helium, is highly preionized by means of an axial current discharge with the shock waves being initiated during the afterglow period of the preionization. Measurements have shown that the plasma is in local thermal equilibrium and nearly completely ionized during the early afterglow period of the preionization. Typical temperatures and electron densities are in the order of 22,000°K and 3×10^{16} electrons/cm^3. Gasdynamic shock waves were studied and the results compared to the theory presented by Jaffrin and Probstein. It was possible to verify the existence of, and quantitatively measure the thickness of the first layer, as predicted by their theory. Magnetohydrodynamic effects were studied via provision of an axial magnetic field. Magnetic field jumps and currents were observed in the shock front and found to be completely stable as long as the shock waves could be observed. It was found that these effects did not appear if either the applied magnetic field or preionization were absent. (auth) (STAR)

39077 (REIC-TR-18) MEASUREMENT ON THE PROPAGATION CONSTANTS OF A SLOW WAVE IN A PLASMA FILLED CYLINDRICAL WAVEGUIDE WITH AN AXIAL MAGNETIC FIELD. Kihara, Masahiko; Ono, Shoichi; Shibata, Yukio (Tohoku Univ., Sendai (Japan). Research Inst. of Electrical Communication). 1967. 33p. Dep.

An experimental device was used in which both the propagation characteristics of slow waves and the characteristics of the plasma itself could be measured simultaneously. Detailed measurements were made of the phase and attenuation constants and compared with theoretical results. The measured phase constants agreed well with the theoretical value of uniform density model, except at particular magnetic fields arising from anomalous phenomena. While the attenuation constants were compared with the simple analysis considering the electron–neutral atom collision. (M.O.W.)

39078 (SC-RR-68-171) ON THE FORM OF INELASTIC TRANSPORT CROSS SECTIONS FOR PLASMAS. Fox, R. L. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1968. Contract AT(29-1)-789. 12p. Dep. CFSTI.

Expressions for the cross sections required to calculate transport properties are derived from the collision term of the Boltzmann equation. The inelastic diffusion cross sections are calculated for electron excitation of the first excited states of hydrogen. Comparisons between the inelastic diffusion cross sections and the cross sections obtained using a $(1-\cos\theta)$ weighting factor show order of magnitude differences at certain energies. (auth)

39079 (SC-T-68-1530) MEASUREMENT OF THE TRANSITION PROBABILITY AS WELL AS HALF VALUE WIDTH AND DISLOCATION OF Ar I LINES IN THERMALLY LUMINESCENT PLASMAS. Gericke, William E. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Astrophys., 53: 68-79(1961). 15p. Dep. CFSTI.

The transition probabilities were measured of 20 Ar I lines in the spectrum range $\lambda\lambda = 4150$ to 6060 Å, as well as half value widths and dislocations of a total of 38 Ar I lines in thermally luminescent plasmas. The temperature was varied between 10,890 and 13,250°K; this corresponds to a variation in the electronic density, where the factor of change is 3.8. (auth)

39080 (UCRL-70849) LARGE APERTURE GLASS DISC LASER SYSTEM. Swain, J. E.; Kidder, R. E.; Pettipiece, K.; Rainer, F.; Baird, E. D.; Loth, B. (California Univ., Livermore. Lawrence Radiation Lab.). May 14, 1968. 28p. (CONF-680522-1). Dep. CFSTI.

From International Quantum Electronics Conference, Miami, Fla.

A study of a glass laser designed to operate at extremely high power and brightness for possible use in the production of strong shock waves and high-temperature plasmas is presented. The design, which uses tilted face-pumped discs of neodymium-doped glass, is a most promising approach to such applications. The advantages and disadvantages of the four proposed ways to use such a laser are considered. To test the disc concept, a system of five 12.5-cm-diameter, 1.25-cm-thick discs was constructed. Design considerations and the results of several measurements with the experimental system are presented. Measurements of the single-pass gain of the five discs showed a gain coefficient of 0.054/cm, which indicates an energy storage of 0.68 joule/cm^3, or 100 joules per disc. The design of a 15-disc unit with a 90-meter path facility, now under construction for continuing experimentation, will be brought to full power (near the damage limit). (auth)

39081 (UCRL-71205) COMPUTATIONAL PROBLEMS IN PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR RESEARCH. Killeen, John (California Univ., Livermore. Lawrence Radiation Lab.). July 8, 1968. Contract W-7405-eng-48. 96p. Dep. CFSTI.

Numerical calculational methods for plasma physics are described for each of the following: pinch experiments, resistive instabilities, finite-β equilibria, Fokker–Planck equation, and the Vlasov equation. (M.O.W.)

39082 SUPERSONIC FLOW OF INVISCID COMPRESSIBLE PLASMAS WITH A FINITE TENSOR CONDUCTIVITY IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. Shih, Lung Yu. Toronto, Univ. of Toronto, 1967.

Thesis.

A method of determining the macroscopic interaction between the motion of a compressible plasma and electromagnetic fields has been developed. The plasma is considered as an electrically conducting fluid with finite conductivity. The viscosity and heat conduction are neglected. The effect of Hall current and ion slip is considered. Since in general insulated walls may be present to influence the Hall current distribution, charge separation occurs and an electric field is necessary to satisfy the continuity equation for the electric current and the boundary conditions. This electric field has been taken into account. The flow under consideration is supersonic and for the practical calculations cases are selected in which a finite expansion around a sharp corner is present. Cases are considered in which the magnetic Reynolds number, although small, cannot be assumed to be zero. The procedure used in this report is based upon a method of successive approximations and is capable of giving solutions for the effect of the induced magnetic field. The entire system of fundamental equations for electromagnetohydrodynamics may be separated into three subsystems: the hydrodynamic, the electric, and the magnetic systems. Since the flow under consideration is supersonic, the method of characteristics has been used for the solution to the hydrodynamic system. Because the magnetic system is elliptic with an unbounded domain, it is solved by means of the method of an integral system that is bounded, the Hall current and the related physical quantities may be solved by the relaxation method. Numerical computations have been made for both two-dimensional and axisymmetric models for cases in which the flow first expands around a sharp corner, then flows through a divergent duct with insulated walls. The applied magnetic field is parallel to the undisturbed upstream flow direction. (Disser. Abstr.)

39083 INTERNAL MAGNETO-GRAVITY PLASMA WAVES. McLellan IV, Alden. Reno, Nev., Univ. of Nevada, 1967. 121p.

Thesis.

An analysis of wave motion in a compressible isothermal medium under the influence of gravity is presented. The dispersion

relation governing the wave propagation is derived from the linearized equations of fluid dynamics and thermodynamics, and arranged in a nondimensional form. Penetration depths, frequency cutoffs, and particle orbits are calculated under the assumption of an ideal gas. With the nondimensional form of the dispersion relation these data can be expressed in a form independent of the constants describing a particular atmosphere. The results are conveniently displayed on a number of diagrams valid for monatomic and diatomic gases. Dissipative effects arising from viscosity and heat conduction are neglected. Small-amplitude low-frequency waves are treated in a plasma of infinite conductivity in the presence of magnetic and gravitational fields. In general, there are three kinds of wave motion; namely, acoustic, gravity, and hydromagnetic. In this analysis, three wave modes were found which were called the +mode, −mode, and the Alfven mode. Each mode is strongly coupled to each of the three kinds of motions, with the exception of the Alfven mode. The Alfven mode is independent of compressibility and gravity, since it can be separated from the dispersion relation. The local dispersion relation is derived and expressed in a nondimensional form independent of the constants describing a particular atmosphere. This dispersion relation is shown to exhibit the behavior of stable and unstable modes of wave propagation, which are displayed on a number of graphs. The variation of the density with height is taken into account by a generalized WKB method. Equations are found which give the height at which wave reflection occurs. This determines the maximum heights up to which the three modes can propagate. (Disser. Abstr.)

39084 THEORY OF VLASOV PLASMA OSCILLATION IN A MAGNETIC FIELD. Watanabe, Yoiti (Osaka Univ.). J. Phys. Soc. Jap., 25: 250-9(July 1968).

The eigenvalue theory of plasma oscillations, developed by Case and other authors, is extended for the case where the waves run obliquely to the direction of external magnetic field. The plasma is spatially homogeneous and has a general equilibrium distribution of electron velocity. Many elliptically polarized high harmonic modes overlap in the induced wave of electric field, each of the modes having different characteristic phase velocity. The superposition, unavoidable by the choice of the initial condition, yields anharmonic oscillations. The spectral structure of the characteristic phase velocity is partly identical with the one derived from the dispersion equation of the density waves, and partly analogous to the energy spectrum due to the azimuthal and the magnetic quantum numbers. (auth)

39085 MICROWAVE SCATTERING FROM ANISOTROPIC PLASMA TURBULENCE. Granatstein, V. L. (Bell Telephone Labs., Inc., Whippany, N. J.). Appl. Phys. Lett., 13: 37-9 (July 1, 1968).

Microwaves are scattered from an under-dense turbulent plasma. The plasma fluctuations are induced by the strong flow of gas through a discharge tube. The variation of scattered power as a function of scattering angle and angle of incidence is shown to be consistent with the spectral content of the plasma fluctuations as resolved by electrostatic probes provided that the turbulence is anisotropic with thin eddies streched along the flow axis. An independent check for the existence of this anisotropy is obtained by observing that the backscattered signal becomes increasingly depolarized as grazing incidence is approached. (auth)

39086 RESONANCE INTERACTION OF FLUTE OSCILLATIONS WITH ION LARMOR DRIFT. Timofeev, A. V. (Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 99-107(May 1968).

It is found that, in a regime in which flute oscillations are usually assumed to be stabilized effects of the finite Larmor radius, they are characterized by resonances with the ion Larmor drift. It is shown that a correct study of these resonances requires direct use of an integral equation, without expansion in the small Larmor radius. The initial value problem is solved by the method of Laplace transformation, and it is shown that the flute instabilities are indeed stable. (auth)

39087 KINETIC THEORY OF A WEAKLY TURBULENT PLASMA. II. FUNDAMENTAL EQUATIONS. Kurasawa, Takasi; Matsuura, Kenya (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 32: 265-79(1968).

The fundamental equations in kinetics of a weakly turbulent plasma relating to ion waves are derived by using the interaction Hamiltonians which describe the elementary processes of the couplings between particles and plasma waves. From a point of view of such elementary processes, the mode-mode coupling of ion waves is discussed. The discussion shows that the equation for it in the short-wavelength region is the same as that describing the mode-mode coupling of electron waves. However, in the long-wavelength region or in the region of wave numbers $k \sim k_e$ (where k_e is the Debye cutoff wave number for electrons), the scattering processes of ion waves by ions in which electrons participate as the intermediate states and the scattering processes of ion waves by electrons become also important and the equations for the mode-mode coupling of ion waves have the very complicated form unlike the case of electron waves. The equations in the stage of the quasi-linear theory and the equations of three-wave coupling (the coupling among two modes of electron wave and a single mode of ion wave) are consistent with the corresponding equations derived by a usual kinetic theory of plasma. (auth)

39088 THE CONNECTION BETWEEN MOVING AND STANDING STRIATIONS IN A D.C. GLOW DISCHARGE IN Ne. Ruzicka, T. (Inst. of Physics, Prague). Czech. J. Phys., 18: 928-36 (1968).

The paper describes the standing structure (standing ionization waves) in a dc glow discharge in Ne at low currents, and its connection with moving ionization waves. Three types of standing waves were found and associated with the dispersion curves established from measurements of all three types of moving waves. Thus one wavelength of standing waves is associated with each dispersion curve related to one type of moving ionization waves. (auth)

39089 ABSORPTION OF MICROWAVES BY AN IONIZED GAS NEAR THE ELECTRON CYCLOTRON HARMONIC FREQUENCIES. Bocchieri, P.; Crosignani, E.; Siragusa, G. (Univ., Pavia, Italy. GNEQP, Pavia, Italy). Nuovo Cim., 56B: 173-82(July 11, 1968).

The shape of the spectrum of the microwaves absorbed by an ionized gas near the multiples of the cyclotron frequency of the electrons in magnetic field is studied, with particular reference to the first harmonic. This spectrum is made up by various lines one of which is at the exact harmonic frequency. This line is interpreted on the basis of Simon and Rosenbluth theory, while the others are connected with the propagation of electrostatic waves in the plasma. Insofar as these waves are concerned the experiments give support to the theory of Stix of the conversion between the es modes and the Q.T-X mode for frequencies near the upper hybrid frequency. (auth)

39090 ON THE FORMAL DEVELOPMENTS IN KINETIC THEORY. II. THE ASYMPTOTIC MASTER EQUATIONS. Baus, M. (Univ. of Brussels). Bull. Cl. Sci. Acad. Roy. Belg., 53: 1332-51(1967).

The asymptotic theory of the exact master equations is discussed. (auth)

39091 ON THE FORMAL DEVELOPMENTS IN KINETIC THEORY. III. APPLICATIONS. Baus, M. (Univ. of Brussels). Bull. Cl. Sci. Acad. Roy. Belg., 53: 1352-64(1967).

The formal techniques introduced in parts I and II were applied to the Lorentz transformations of the asymptotic master equations. The different forms of the collision operator are also briefly discussed. (auth)

39092 DEVIATIONS FROM MAXWELLIAN DISTRIBUTION OF ELECTRON ENERGIES IN A WEAKLY IONIZED PLASMA. Sonin, E. B. (Inst. of Semiconductors, Leningrad). Zh. Eksp. Teor. Fiz., 54: 1554-61(May 1968). (In Russian).

The problem of determining the distribution function of fast electrons and number density of atoms on the first excited level when the first excitation potential exceeds the mean electron energy is considered. It is shown that in a number of cases the transitions between excited states in the atoms may Maxwellize the electron energy distribution for arbitrarily weak electron–electron collisions. If such transitions are not taken into account arbitrarily large deviations from the Maxwellian distribution may occur. The electron temperatures below which spatial inhomogeneity of the fast electron distribution function may not be taken into account are also estimated. (auth)

39093 INVESTIGATION OF A MICROWAVE-GENERATED PLASMA IN A NONUNIFORM MAGNETIC FIELD. Crimi, Giles Frank. Philadelphia, Univ. of Pennsylvania, 1967. 146p. Thesis.

The physics of a model which closely corresponds to a high-power microwave magnetoplasma thruster has been analyzed. This work centers on a successful comparison of the physical phenomena predicted by a simplified theoretical model with experimental data taken on such a thruster. The experimental system consisted of a pulsed low density argon plasma, generated by a high-power microwave pulse in a waveguide and streaming freely into a vacuum tank along a nonuniform magnetic field. For the purpose of analysis, the simplified theoretical model is divided into three regions according to principal processes. In Region I, the input gas pulse is subject to high frequency breakdown in a nearly uniform, nearly resonant magnetic field. The input rf wave propagation is assumed to be described here by a

standard dispersion relation developed for a hot magnetoplasma. The plasma buildup in this region may cause a reflection of the left-hand rotating component of the input rf, while the right-hand component continues to propagate along the magnetic field lines in the Whistler mode. In Region II, the uniform magnetic field includes the condition of electron cyclotron resonance. Here, the transverse velocity of the electrons is sharply increased at the expense of the remaining component of the input electromagnetic wave. At this point the rf is considered to be completely eliminated according to a Landau damping type of process. In Region III, the plasma is accelerated. The electrons are expelled along the field lines due to the $(\bar{M} \cdot \mathrm{GRAD})\ \bar{B}$ force, where $\bar{M}$ is the magnetic moment of an electron in a nonuniform field $\bar{B}$. This directed motion causes a space-charge to be established with the relatively cool ions. This coupling then permits a collisionless acceleration of the ions as the transverse velocity of the electrons is converted to longitudinal velocity in the decaying field. Energy loss mechanisms due to particle radiation and charge transfer are also included in this region. Several unique experimental measurements have been included. An electron cyclotron resonance surface due to the nonuniform magnetic field was detected. Because of this surface, rf wave sampling occurred in the center of the plasma stream, but propagation was allowed at larger radii in the stream. The rf damping at resonance was decisive, attenuating the signal by 10 to 100 db even though only a spatially finite resonance surface existed. As predicted by the theory of a hot magnetoplasma, the Doppler shift of the resonance point was detected. Langmuir probes were successfully employed in the severe environment of low density and high magnetic field (10^{13} cm^{-3} and 3000 gauss, respectively) to determine the average electron temperature (approximately 50 eV). Terminal ion energies were determined by means of a four-gridded stopping potential probe. Principal plasma radiation intensities in Region III were computed and compared. These computations, as well as observations from this and experiments of others under similar conditions, indicate that line radiation is the dominant energy loss mechanism. Based on this conclusion a summary energy balance relating input rf power to output thrust efficiency is included. It is found that the choice of input gas and operating power level are important considerations in the design of a plasma accelerator. (Disser. Abstr.)

39094 ENERGY EXCHANGE IN HIGH-PRESSURE DISCHARGE PLASMAS EXCITED IN DIATOMIC GASES. Janca, J. (Purkyne Univ., Brno). Czech. J. Phys., 18: 919-27(1968).

The energy loss that electrons sustain in inelastic collisions in high-pressure discharge plasmas excited in molecular gases is strongly affected by the vibrational temperature of the molecules and the temperature of the neutral gas. The theoretically computed average fractional energy loss due to collision with a gas molecule is far higher than the respective experimental values available at present. The energy exchange occurring between the various components of a discharge plasma is also influenced to a considerable degree by the process of electronic and molecular vibrational de-excitation. (auth)

39095 EXPERIMENTAL CONFIRMATION OF THE EXISTENCE OF STATIONARY SELF-COMPRESSING PLASMA CURRENTS. Morozov, A. I.; Kovrov, P. E.; Vinogradova, A. K. JETP Lett. (USSR) (Engl. Transl.), 7: 199-201(Apr. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 257-60(Apr. 20, 1968).

A magnetoplasma compressor was built to confirm the existence of an effect of stationary compression of a plasma jet. Nitrogen was fed to the discharge gap with a pulsed valve. The existence of a compression effect was confirmed. (M.O.W.)

39096 SPACE-CHARGE WAVE PROPAGATION IN CYLINDRICAL PLASMA COLUMNS. Articolo, George Anthony. Philadelphia, Temple Univ., 1967. 336p.

Thesis.

A theoretical and experimental study was made of space charge wave propagation in the positive column of a cesium arc discharge which was coaxially centered in a slotted waveguide. Measurements on the temperature and calculations on the pressure and degree of ionization indicated the positive column to be very weakly ionized and of low pressure. Coupling of a weak rf signal at the cathode end of the tube caused the excitation of space charge waves which propagated from the cathode end of the positive column to the anode end. Due to the impedance mismatch at the anode end of the tube, the reflected wave was mixed with the incident wave to give distinct standing wave patterns which were detected by a capacitor probe through the slotted waveguide. Experimental measurements upon the wave attenuation dispersion relation ($\alpha(\omega)$) and wave number dispersion relation ($\beta(\omega)$) for the waves were made for various values of the dc stream current through the positive column. The theoretical portion of this study was an attempt to present and analyze a plasma model which would allow for the derivation of theoretical expressions for $\alpha(\omega)$ and $\beta(\omega)$. (Diss. Abstr.) (TSS)

39097 EXPERIMENTAL INVESTIGATION OF THE DYNAMICS OF ELECTROMAGNETICALLY DRIVEN CONVERGENT CYLINDRICAL SHOCK WAVE. Kogelschatz, U.; Boetticher, W.; Dammann, H.; Kleist, G. (Univ., Kiel). Z. Naturforsch., 23a, 514-20(Apr. 1968). (In German).

In the convergent cylindrical shock wave of a z-pinch discharge (diameter/length ratio: 44 cm per 10 cm), magnetic probe measurements have been made of the current density and the velocity of the current sheet. For discharges in helium, argon and krypton at mass densities from 2.2×10^{-7} to 5.5×10^{-6} g/cm^3 one finds: (1) Only a small portion of the total current contracts with the shock wave. The direction of this current is maintained even when the total current reverses. (2) The gas pressure behind the shock front is a constant for each gas independent of the filling pressure. (3) At small radii the contraction is determined by the inertia of the moving plasma only. (4) With higher filling pressures a considerable part of the small contracting current flows ahead of the shock front. (auth)

39098 NONLINEAR EFFECTS IN BOUNDED COMPRESSIBLE PLASMAS EXCITED BY EXTERNAL SOURCES. Paik, S. F. (Electronics Research Center, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 377-8 (May 1968).

The disturbances in a plasma caused by irradiation by two electromagnetic waves are investigated. The magnitude of these nonlinearly excited currents in the plasma is small, but these currents may excite other propagating disturbances in the plasma. (M.O.W.)

39099 A DETERMINATION METHOD OF THE TIME OF H = 0 OF THETA PINCH FIELD WITH A PEAKING-STRIP. Nogi, Yasuyuki (Nihon Univ., Tokyo). Jap. J. Appl. Phys., 7: 680(June 1968).

The time of H = 0 must be accurately found out in order to interpret various phenomena evolving rapidly with time. In this measurement the time was determined with use of a peaking-strip in high rise rate of a magnetic field, $10^8 \sim 10^9$ oersted/second. The peaking-strip, 3% Mo Permalloy, was designed thin for reducing the eddy current. The dimensions are 0.5 mm in width, 4 μ in thickness and 3 cm in length. A five-turn pickup coil is wound tightly around the peaking-strip for making the measurement of the delay time. Then it is set along the axis of a theta pinch field. The results are described. (M.O.W.)

39100 STUDIES OF ROTATION PLASMA. Umarov, G. Ya.; Suyarov, N.; Baklitskii, B. E. Dokl. Akad. Nauk Uzb. SSR, No. 12, 19-20(1967). (In Russian).

Data are given on the basic parameters and dynamics of rotating plasma. Relations describing the rise of gas ionization as a function of increased current passing through plasma are presented. (R.V.J.)

39101 EXCITATION OF ELECTROMAGNETIC OSCILLATIONS IN A MAGNETOACTIVE PLASMA BY A MODULATED BEAM. Pyatak, A. I.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 13: 656-63(Apr. 1968). (In Russian).

The interaction of a density-modulated beam with plasma in a constant magnetic field was investigated. The tensor of dielectric permeability of a cold plasma through which a cold modulated beam propagates is obtained. Excitation of low-frequency oscillations and electromagnetic oscillations propagating transverse to the beam motion was studied. It was found that during the interactions, regions of instability become narrower and increments of excitation are reduced. (R.V.J.)

39102 TURBULENT HEATING OF A PLASMA BY ELECTROMAGNETIC WAVES. Aref'ev, V. I.; Kovan, I. A.; Rudakov, L. I. JETP Lett. (USSR) (Engl. Transl.), 7: 223-6(Apr. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 286-90(Apr. 20, 1968).

It is shown that under certain conditions an electric current flowing through a plasma can be the cause of instability. An equation is presented for the heating of the plasma ions. The limiting values of the ion temperature and wave decrement in the plasma are determined and compared with previous experimental results. (J.H.R.)

39103 TEST-PARTICLE ANALYSIS OF PLASMA TURBULENCE IN ASTROPHYSICS. Hall, Donald Eugene. Stanford, Calif., Stanford Univ., 1967. 120p.

Thesis.

An important problem of long standing in astrophysics is that of the natural occurrence of charged particles of extremely high en-

ergy. The classical form of the problem is that of the origin of cosmic rays, but to this may now be added observations of particles generated in solar flares, in and near the magnetosphere of the earth, in supernovae, in extragalactic radio sources, and in certain laboratory plasmas. In each of these cases, there is reason to believe that the particle acceleration is connected with plasma turbulence or instability. To investigate the origin of these high-energy particles, an idealized problem has been studied. Test particles are pictured in a general configuration of steady or slowly changing electromagnetic fields, to which an arbitrary spectrum of small random fluctuations is added to represent weak plasma turbulence. The behavior of the particles is found in terms resembling the quasi-linear theory of plasma disturbances, and advantages of this method over the previously used Fokker-Planck approach are described. The limits of applicability of the theory are stated and explained. The result takes the form of a generalized diffusion equation in the phase space; the "diffusion coefficients" are determined by past-history integrals of the second-order correlation functions of the fluctuations, evaluated for pairs of points lying on "unperturbed orbits." The particular case considered in detail is that of relativistic particles moving in stochastic fields in an otherwise uniformly magnetized plasma. Limiting cases of acceleration, scattering, and spatial diffusion are obtained and discussed; and the results are shown to reduce to those found by other workers (such as Sturrock, Puri, and Jokipii) in appropriate limits. Transverse cyclotron acceleration by low-frequency waves is proposed as the most significant process of stochastic acceleration because of a "selection rule" which is expected to increase its effectiveness as the particle energy increases, if there is a "universal spectrum" of plasma turbulence for which amplitude is a decreasing function of mode frequency. The loss of energy by synchrotron radiation is also important for electrons in several of the situations mentioned. This is considered both alone and in combination with stochastic acceleration and other effects, with special attention being given to the possibilities for generating power-law energy spectra. The relevant properties of quasars are reviewed and preliminary comparison is made between the model calculations and the observational data. It is concluded that stochastic acceleration is important in the generation of high-energy particles, that the present calculation has shown how this may reasonably happen, and that this process deserves further and more detailed consideration. Several suggestions are offered for additional observational and theoretical study. (Disser. Abstr.)

39104 SOME PROBLEMS IN THE STATISTICAL MECHANICS OF TWO-COMPONENT PLASMAS. Dekeyser, Raf. Meded. Kon. Vlaam. Acad. Wetensch., Belg., Kl. Wetensch., 30: 7-75(1968). (In French).

A method for solving problems in two-component plasma is described. This method is used to investigate the partition function and the dipole radiation intensity. (M.O.W.)

39105 CYCLOTRON HARMONIC WAVE PHENOMENA. Mantei, Thomas Daniel. Stanford, Calif., Stanford Univ., 1967. 116p.

Thesis.

The principal areas of investigation were steady-state and pulsed wave transmission, pulse-stimulated resonance excitation, plasma resonance rectification effects, and the behavior of the plasma capacitor in a magnetic field. All experiments were carried out in a low-pressure positive column in argon, immersed in a uniform, static, externally applied magnetic field. Attention is restricted to situations in which the rf electric field is perpendicular to the static magnetic field. For this case, the waves are undamped, and their propagation is limited to a series of passbands associated with the harmonics of the electron cyclotron frequency, ω_c. (TSS) (Disser. Abstr.)

39106 EFFECT OF COLLISIONS ON THE GENERATION OF HARMONICS IN NITROGEN. Varnum, William Sloan. Tallahassee, Florida State Univ., 1967. 124p.

Thesis.

The effect of collisions on the generation of harmonics in ionized molecular nitrogen subjected to an alternating electric field is examined theoretically. The thirteen moment approximation has been used for the electron distribution function. In the case of a homogeneous alternating electric field in a uniform plasma it is shown that no second harmonic is generated, but a third harmonic is produced. The magnitude of the third harmonic current density is calculated. The nonlinearity which must be present in the kinetic equations in order to produce harmonics is assumed to arise from velocity dependent electron–molecule collision frequencies. Available elastic and inelastic electron–molecule collision cross sections have been included in the calculations. The theoretical calculation of the third harmonic power generated is compared with two related microwave discharge experiments. Qualitative agreement of theory with experiment has been obtained. (Disser. Abstr.)

39107 NEGATIVE CYCLOTRON RESONANCE ABSORPTION. Wachtel, Jonathan Mark. New Haven, Yale Univ., 1967. 108p.

Thesis.

The kinetic theory of waves in an infinite plasma in a uniform, constant magnetic field predicts that radiation near the cyclotron frequency in a sufficiently nonthermal plasma may grow in time. One effect which can cause such growth or negative cyclotron resonance absorption of radiation with propagates perpendicular to the magnetic field direction is the relativistic energy dependence of the electron's mass. Another is the energy dependence of the electron–atom collision cross section for low energy electrons in a neutral gas background. The cyclotron resonance absorption of microwave energy by monoenergetic electrons which drift through a cavity resonator has been measured in order to verify these predictions. In each case the observed absorption spectra are similar to those calculated in a perturbation theoretical solution of the Boltzmann equation treating the cyclotron resonance interaction between the electron beam and the bounded standing wave fields of the cavity resonator. An experiment which exhibits the radiative response in time of a weakly relativistic, monoenergetic electron ensemble to a short pulse of cyclotron resonance radiation is also described. The radiation calculated in an exact solution of the Boltzmann equation is found to occur in repetitive bursts of diminishing amplitude following the stimulating pulse. Experiment and theory are observed to be in qualitative agreement. (Disser. Abstr.)

39108 ENHANCEMENT OF ELECTRICAL CONDUCTIVITY IN A GAS. August, Henry (North American Aviation, Inc., Los Angeles). pp 297-301 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

An analytical and experimental investigation was performed to investigate the plasma characteristics induced in air by alpha particle emissions from radioisotope material. Primary ionizations are caused by collisions between alpha particles and the gas particles, and many of these collisions produce sufficiently energetic electrons to cause secondary ionizations. The temporal average energy of the resulting swarm of free electrons was estimated to be approximately 20 eV, which is far above that of the gas particles (~0.025 eV). Associated with these induced levels of electron energy are reduced probabilities that the freed electrons will be lost through attachment and dissociative recombination processes, thereby attaining an appreciable level of electrical conductivity in the gas. Estimates of average electron density through an ionized air layer adjacent to an alpha particle emitting surface having 2 millicuries/inch^2 were computed to be 10^9 to 10^{10} e/cm^3, and its graded distribution normal to the surface was also estimated. Laboratory measurements support the analytical approach and estimated results. (auth)

39109 ELECTROSTATIC WAVES IN BOUNDED HOT PLASMAS. Omura, Masayuki. Stanford, Calif., Stanford Univ., 1967. 145p.

Thesis.

The study is broadly divided into two parts. The first section investigates waves in a diode system with no dc magnetic field applied. A dc analysis of the equilibrium plasma produced within a thermionic diode is undertaken to provide a basis for the rf analysis, and expected plasma densities in the diode are computed for a variety of practical situations. Electrostatic wave resonances in the diode are predicted by using the hydrodynamic model for the nonuniform plasma. The impedance of a uniform plasma diode is obtained by using a kinetic model of the plasma. This model enables us to take into account the end plate electron absorption loss, a process similar to that which causes end plate diffusion in the Q machine. The absorption loss is found to have a large effect on the impedance of the diode. The second part of the report deals with the study of guided waves along a cylindrical column of Maxwellian plasma in a magnetic field. A dc study of the plasma column is first conducted. Theoretical density and current profiles are obtained and are compared with the measured results. Since an rf analysis using a self-consistent dc solution is quite involved, the plasma column is approximated by a uniform plasma with a sharp boundary and no drift. To obtain the rf fields in such a column, a plane-wave solution for an infinite Maxwellian plasma in an applied magnetic field is first obtained. By superimposing infinitely many plane waves, the fields within the column are constructed, and by matching the appropriate fields at the boundary, a dispersion relation is derived. The solutions to the dispersion relation reveal the existence of a new type of unstable waves. When only the electrons

are assumed to respond to the electric field, the surface waves which propagate when $\omega_{ce} < \omega_{pe}$ are found to be unstable. When the ion motion is included, additional unstable surface waves are obtained whenever $\omega_{ci} < \omega_{pi}$. A study of the instability shows that it is due to finite Larmor radii effects and is driven by the transverse energy of the particles. While the "electron" surface wave instability is relatively weak and can easily be stabilized by making $\omega_{ce} > \omega_{pe}$, the "ion" surface wave instability is found to be very strong, and the stabilizing condition of $\omega_{ci} > \omega_{pi}$ is not easily attained in high density plasmas such as those in fusion machines. Thus, the unstable ion surface waves may have a serious effect on the containment of the fusion plasma. (Disser. Abstr.)

39110 EXACT LOWER BOUNDS FOR SOME EQUILIBRIUM PROPERTIES OF A CLASSICAL ONE-COMPONENT PLASMA. Mermin, N. D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 171: 272-5(July 5, 1968).

It is shown that the internal energy, Helmholtz free energy, and Fourier-transformed static structure factor S(k), for a classical electron gas with uniform positive background, are all bounded below by their Debye–Hückel values. This is true whether the equilibrium state is uniform or crystalline and whether periodic or impenetrable-wall boundary conditions are used. (auth)

39111 CORRELATION FUNCTION IN A PLASMA AT ZERO PARTICLE SEPARATION. Davies, B.; Storer, R. G. (The Flinders Univ., South Australia). Phys. Rev., 171: 150-1(July 5, 1968).

The radial distribution functions are derived at zero particle separation for like and unlike particles in a plasma. No account is taken of many-body (screening) effects, but the sum over Coulomb wave functions in the two-particle density matrix is evaluated exactly to give a convergent power series in the dimensionless parameter $\gamma^{\frac{1}{2}}$, where $\gamma = 2\mu e^4/\hbar^2 kT$, and μ is the reduced mass of the two-particle system. (auth)

39112 MONTE CARLO STUDY OF A HYDROGENOUS PLASMA NEAR THE IONIZATION TEMPERATURE. Barker, A. A. (Univ. of Adelaide). Phys. Rev., 171: 186-8(July 5, 1968).

Results of a recent Monte Carlo study of a hydrogenous plasma near the ionization temperature show that distribution functions obtained are unusually sensitive to two parameters. The first is the cutoff imposed at small radii on the Coulomb potential between unlike particles, and it becomes necessary to consider quantum-mechanical effects at these radii. The second is the maximum step length Δ through which the particles are allowed to move in the Monte Carlo procedure. It appears that near the ionization temperature the plasma behaves as a mixture of two phases, one ionized, the other un-ionized, and the magnitude chosen for Δ influences which phase dominates. (auth)

39113 CONTINUUM THEORY OF THOMSON SCATTERING. Tanenbaum, B. Samuel (Cornell Univ., Arecibo, Puerto Rico). Phys. Rev., 171: 215-21(July 5, 1968).

The theory of incoherent (Thomson) scattering of electromagnetic waves by thermal fluctuations in a plasma is rederived using continuum equations instead of kinetic theory. Because of the inherent simplicity of this approach, it is possible to extend the theory by including the effect of density fluctuations of the neutral molecules upon the scattering. The following results are obtained from the continuum theory: (1) The total predicted scattered power is exactly the same as in the previous kinetic theories. (2) The frequency spectrum of the scattered signal when neutral fluctuations are neglected agrees very well with the spectrum obtained using kinetic theory (with the Bhatnagar–Gross–Krook model for collisions) whenever λ_{in}, the ion-neutral mean free path, is smaller than λ_ϕ, the wave number of the incident signal. (3) The major difference in the spectrum when the neutral fluctuations are included is the addition of two resonances shifted from the signal frequency by $\pm kU_n$, where $k = 4\pi/\lambda_\phi$, and U_n is the neutral sound speed. For a weakly ionized gas, these resonances are found to be significant whenever $\lambda_{in} < r^{\frac{1}{2}}\lambda_\phi$, with r the ratio of the electron density to the neutral-atom density. (auth)

39114 ELECTROMAGNETICS AND PLASMAS. Wait, James R. New York, Holt, Rinehart and Winston, Inc., 1968. 153p. $7.95.

Nine chapters discuss the following: (1) general magnetoionic theory, (2) applications of magnetoionic theory, (3) elementary Boltzmann theory for the dielectric constant, (4) radiation from a dipole in a warm plasma, (5) radiation from an antenna in a warm plasma, (6) boundary effects for waves in warm plasma, (7) hydrodynamic theory for probes in warm plasma, (8) waves in inhomogeneous warm plasma, and (9) waves in a warm anisotropic plasma. (M.O.W.)

39115 SURFACE WAVES IN A CURRENT-CARRYING PLASMA ENCLOSED BY CONDUCTING WALLS. Ivanov, Yu. B.; Lovetskii, E. E. (Moscow Engineering Physics Inst.). Zh. Tekh. Fiz., 38: 8-13(Jan. 1968). (In Russian).

The two-fluid hydrodynamic approximation is used to discuss the potential oscillations of a cold current-carrying plasma cylinder or slab within or between conducting walls in a magnetic field parallel to the axis of the cylinder or the plane of the slab. The plasma is assumed to be separated from the conducting wall by a finite vacuum gap; and the plasma–vacuum boundary is assumed to be sharp. The conductivity of the walls is assumed to be large but finite. There are considered oscillations that propagate in an arbitrary direction in the plane of the slab or, in the cylindrical case, whose propagation vectors have nonvanishing axial and azimuthal components. The dispersion equations are derived and their roots are discussed. Stability conditions are obtained and formulas are given for the growth rates of the unstable oscillations. It is found that when the vacuum gap is not too short there can be both low- and high-frequency unstable oscillations. In sufficiently thin slabs the growth rate of the unstable oscillations increases with increasing slab thickness, but in the cylindrical case the growth rate depends very weakly on the radius of the plasma filament. When the vacuum gap is very short the oscillation frequencies and growth rates can depend on the conductivity of the walls. (ATD)

39116 FLUTE OSCILLATIONS OF A RAREFIED PLASMA WITH UNCOMPENSATED SPACE CHARGE. II. Timofeev, A. V. Zh. Tekh. Fiz., 38: 14-23(Jan. 1968). (In Russian).

The present paper represents a continuation of earlier work of the author (ZhTf, 36, No. 10, 1966) in which he showed with the aid of indeterminancy relations analogous to those of quantum mechanics that under certain conditions there may be no local proper oscillations of a rarefied plasma with uncompensated space charge provided the radial electric field varies linearly with distance. In the present paper it is shown more generally that absence of proper oscillations is characteristic of a system with a spatially varying plasma velocity (a slipping system). The calculations are based on the two-fluid hydrodynamic approximation. An equation is derived for the perturbation to the electric potential; this equation has the form of a one-dimensional Schrödinger equation and is also satisfied by the perturbation to the stream function for the plane parallel flow of an ideal fluid. This equation is discussed in the "quasiclassical" (WKB) approximation. Much of the paper is devoted to a lengthy discussion from different points of view of the proper matching of the WKB solutions to this equation on the two sides of the singular points where the "kinetic energy" vanishes. In this discussion the author disagrees with a statement made by K. G. Budden (Cavendish Lab. Phys. Soc., p. 320, London, 1955) and/or T. Stix (The Theory of Plasma Waves, McGraw-Hill, N. Y.) concerning the behavior of one of the solutions. It is finally concluded that if the electric field is sufficiently strong and varies monotonically, there are no local proper oscillations in the interior of the plasma, and that this conclusion is valid whether or not the WKB approximation is valid in the region of positive kinetic energy. As regards the hydrodynamic application, the present result is a generalization of the theorem of Rayleigh that in the plane parallel flow of a perfect fluid there are no proper oscillations with positive growth rates unless the velocity profile of the flow has a flex point. (ATD)

39117 FORMATION OF SOLUTONS. Berezin, Yu. A. Zh. Tekh. Fiz., 38: 24-7(Jan. 1968). (In Russian).

Some numerical solutions are obtained for the Korteweg–de Vries equation $u_t + uu_x + \beta u_{xxx} = 0$ for propagation of finite amplitude disturbances in a nonlinear dispersive medium. Here u represents the velocity (regarded as the momentum density), β is a parameter, the subscripts indicate differentiation with respect to the time t and the coordinate x, and the equation is written in a reference system moving through the medium at the propagation velocity of small disturbances. From several examples it is tentatively concluded that when the total momentum of the initial disturbance does not vanish there is always formed for any (positive) value of β at least one solitary-wave pulse (soliton) and a spreading train of waves of lower amplitude. When the total momentum of the initial disturbance vanishes, solitons are formed only if β is smaller than a critical value depending on the characteristic linear dimension of the initial disturbance. (ATD)

39118 STUDY OF THE STATIONARY PLASMA EXCITED IN A MAGNETIC FIELD BY THE ACTION OF MICROWAVE POWER. Budnikov, V. N.; Vinogradov, N. I.; Golant, V. E.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 28-35(Jan. 1968). (In Russian).

Investigations of the excitation of hydrogen plasmas in magnetic fields by 9375-MHz microwaves have been continued. For the present work the maximum microwave power was increased to

100 W, and the maximum magnetic field strength to 8 kOe. The plasmas were produced in 2.5-cm-diameter quartz or 2.7-cm-diameter metal tubes. The microwaves were introduced through a 3-cm-diameter cylindrical waveguide enveloping a portion of the discharge tube and excited in the TE_{11} mode; the end of the metal discharge tube projecting into the waveguide was provided with a conical glass window. The longitudinal magnetic field was either uniform or had a magnetic mirror configuration with a mirror ratio from 1.1 to 2.4 and a distance between mirrors of 68 or 32 cm. The electron densities of the plasmas were determined from the resonant frequency shift of a cylindrical cavity resonator enveloping a portion of the quartz discharge tube and resonating in the TM_{010} mode in the 2.5-kMHz region, or a cylindrical cavity resonator formed by a section of the metal discharge tube having an enlarged radius and resonating in the TM_{021} mode in the 17-kMHz region. At hydrogen pressures from 10^{-4} to 10^{-1} mm Hg, plasmas were produced only when the magnetic field strength was within 5% of the electron cyclotron resonance value, but at the higher pressures (above (1 to 3) $\times 10^{-3}$ mm Hg) the plasma continued to exist when the magnetic field strength was varied over a wider range. The persistence of the plasma at nonresonance magnetic field strengths is discussed briefly in terms of resonance with the ordinary and extraordinary waves in the expansion of the exciting microwave field in a series of plane waves propagating obliquely to the axis. Plasmas were obtained at gas pressures below 2×10^{-5} mm Hg by pumping neutral gas out of a discharge tube in which the plasma had already been formed. The minimum pressure to which plasma would persist was lower in the metal discharge tube than in the glass one, did not depend strongly on the microwave power level above 10 W, and was lowest when the magnetic field had the magnetic mirror configuration with a mirror ratio of about 1.1. Electron temperatures and lifetimes were calculated from the pressure and microwave powder dependence of the plasma electron density. The "observed" electron lifetimes obtained in this way were in good agreement with the lifetimes estimated on the basis of diffusion and recombination losses for plasma pressures in the (1 to 3) $\times$ 10^{-4} mm Hg region, but at higher and lower pressures the observed lifetimes were shorter than the estimated ones. The discrepancy at the higher pressures is ascribed to anomalous transverse diffusion, but the discrepancy at the lower pressures is not understood and requires further investigation. (ATD)

39119 THEORY OF AN ELECTRODYNAMIC PLASMA ACCELERATOR WITH INDUCTIVE ENERGY STORAGE. Gurov, V. M.; Khizhnyak, N. A. (Kharkov Aviation Inst.). Zh. Tekh. Fiz., 38: 36-9(Jan. 1968). (In Russian).

With the aid of a computer numerical solutions were obtained to the equations describing the operation of a simplified equivalent circuit for a coaxial plasma gun powered by an inductor rather than, as usual, by a capacitor bank. In the equivalent circuit the plasma gun is represented by a constant resistance in series with an inductance that increases linearly with distance of the plasma puff from the breech of the gun, the storage element is represented by an inductance in series with a resistance, and the circuit breaker is assumed to cause the current from the power supply to decrease exponentially with time. Curves showing the time dependence of the current through the plasma and of the position and velocity of the plasma puff for different values of the parameters are presented and discussed briefly. It is concluded that the use of inductive energy storage not only makes it possible to reduce the weight and size of the storage element, but also significantly affects the dynamics of the acceleration of the plasma, that efficient transfer of energy from the storage element to the plasma is favored by the aperiodic character of the discharge; and that the time constant of the circuit breaker is a very important parameter and should have a value between about 1 and 10 microseconds. (ATD)

39120 ELECTRODYNAMIC PLASMA ACCELERATION IN A CONICAL ELECTRODE SOURCE. Khizhnyak, N. A.; Safronov, B. G.; Vereshchagin, V. L. Zh. Tekh. Fiz., 38: 40-7(Jan. 1968). (In Russian).

A system of equations is presented which describes electrodynamic plasma acceleration in a conical source with a cylindrical feedback conductor. The theoretical results were found to be in good agreement with experimental data obtained with a conical erosion plasma source. It is concluded that electrodynamic plasma acceleration in a conical electrode source is a special case of electrodynamic plasma acceleration in rail-type sources, characterized by a more complex geometry of the guiding electrodes. A plasma acceleration diagram was designed which quite accurately describes changes of the integral bunch parameters in relation to the parameters of the chain. (ATD)

39121 ENERGY LOSS OF A MODULATED AXIAL CURRENT IN A BOUNDED MAGNETOACTIVE PLASMA. Vodyanitskii, A. A.; Kondratenko, A. N. Zh. Tekh. Fiz., 38: 48-58(Jan. 1968). (In Russian).

The energy loss of an axially symmetric current, varying harmonically with time and the axial coordinate, flowing in a plasma cylinder immersed in an axial magnetic field is discussed. The calculations are performed in the hydrodynamic approximation, but the effect of the thermal motions of the plasma particles on the energy loss is taken into account. Maxwell's equations, containing the dielectric tensor that describes the plasma, are solved for cylindrical boundary conditions, and a general expression is derived for the energy loss per unit time per unit length by the current. This expression is simplified for the two cases of a "cylindrical current," when the current density is constant for $r < a$ and vanishes for $r > a$ (r is the radial coordinate and a is a constant), and a "tubular current," when the current density is proportional to $\delta(r - a)$. In an infinite plasma the energy losses are mainly associated with excitation of waves, but in a bounded plasma, when the phase velocity is lower than the velocity of light, the losses are determined by dissipative processes, by Cherenkov absorption at high temperatures and by collision processes at low temperatures. Specific formulas for the energy loss are derived and discussed for a number of special cases, including those of a weak magnetic field, high-frequency oscillations in an arbitrary magnetic field, excitation of low-frequency waves, an infinite nonisothermal plasma, and a bounded nonisothermal plasma. (ATD)

39122 BEAM–PLASMA DISCHARGE IN A WEAK MAGNETIC FIELD. Krivoruchko, S. M.; Medvedev, Yu. V. Zh. Tekh. Fiz., 38: 87-92(Jan. 1968). (In Russian).

Plasma was investigated in the central plane of a magnetic trap having a mirror ratio of 4.3 and a central magnetic field strength of 370 Oe or lower, formed in a 10-cm-diameter, 100-cm-long quartz tube containing hydrogen at pressures from 5×10^{-4} to 2×10^{-3} mm Hg by a 0.35 to 0.5-A pulsed beam of 5 to 10 keV electrons. The measurements were undertaken in order to explore the region of beam–plasma interaction where high-energy transverse electrons just begin to appear. The plasma density was estimated for the attenuation of 3-cm microwaves, x radiation from the plasma was recorded with an NaI(Tl) crystal scintillator, 3- and 10-cm microwave radiation from the plasma was sought (no 3-cm radiation was found), the transverse energy stored in the plasma was measured with a diamagnetic probe (a pickup coil wound on the quartz tube), and the electron temperature of the cold component of the plasma was determined from the relative intensities of the 5015 and 5875 Å lines of helium, introduced into the plasma as an impurity. Fast electrons were present at relatively low magnetic field strengths (down to about 100 Oe), but their number amounted only to some tenths of a percent of the total number of electrons. The fast electrons with energies above about 30 keV were Maxwellianly distributed with temperatures that increased linearly with increasing magnetic field strength from about 10 keV at 210 Oe to about 42 keV at 370 Oe. The electron temperature of the cold component, on the other hand, decreased with increasing magnetic field strength from 90 to 100 eV at 100 Oe to 25 to 30 eV at 350 Oe, although the transverse energy of the plasma either increased slowly with increasing magnetic field strength or went through a flat maximum at a magnetic field strength that depended on the gas pressure. No 3-cm microwave radiation was detected, but 10-cm microwave radiation was observed at magnetic field strengths in the vicinity of 200 Oe and electron beam energies above 6 keV. (ATD)

39123 THEORY OF MICRODISCHARGES IN INTERELECTRODE GAPS. Gerasimenko, V. I. Zh. Tekh. Fiz., 38: 155-62 (Jan. 1968). (In Russian).

The development of microdischarges that precede the breakdown of a vacuum gap between surface-contaminated electrodes is discussed. It is assumed that the microdischarge, initiated by an extraneous particle (for example, by an α particle from the natural background radioactivity), develops by a cascade process in which positive ions from the anode eject negative ions from the contaminated cathode surface and these eject further positive ions from the contaminated anode surface, and is eventually quenched as a result of depletion of the surface contamination. A differential-difference equation describing this process is derived and its solutions are discussed (the equation contains finite differences because of the finite interelectrode ion transit time). The principal parameters in this equation are the number α of negative ions ejected from the cathode by a single incident positive ion, the number β of negative ions ejected from the anode by a single incident negative ion, and the product $\gamma = \alpha.\beta$. From the theory it is concluded that microdischarges transferring charges of 10^{-6} to 10^{-3} coulombs, such as are observed, should have durations of 10^{-2} to 10^{-6} sec; this conclusion is not in conflict with the experimental data on the durations of microdischarges. A detailed comparison

with experiment is not possible at present owing to the lack of sufficient experimental data on the conditions of the electrode surfaces, and the cross sections of the processes that take place when ions strike them. Very small values of $\gamma - 1$, of the order of 10^{-3} to 10^{-4}, are adequate to account for the available data on charge transfer by and duration of microdischarges. (ATD)

39124 ANOMALOUS DECELERATION OF AN ACCELERATED PROTON BEAM IN AN ARC DISCHARGE PLASMA. Tarumov, E. Z.; Bakshaev, Yu. L.; Borzenko, V. L.; Pen'kina, V. S.; Rozanova, V. I. Zh. Tekh. Fiz., 38: 163-70(Jan. 1968). (In Russian).

The interaction of approximately 1-mA beams of 100- to 150-keV protons with hydrogen and helium arc discharge plasmas (arc current, 0.2 to 20 A; charged particle concentration, 10^{10} to 10^{12} cm^{-3}; gas pressure, (1 to 4) $\times 10^{-3}$ mm Hg; anode potential, 150 V; electron temperature, 1 to 3 eV) was investigated in a 100- to 500-Oe longitudinal magnetic field in the presence of a counterflux of 60- to 70-eV electrons with a current density up to 100 mA/cm^2 and an energy spread of ±10 to 20 eV. The 6- to 10-cm-diameter 100-cm-long arc column extended between the anode a ring-shaped hot tungsten cathode in a 12 cm diameter stainless steel tube. Near the cathode there was a winding which, when energized, produced a local magnetic field opposite to the principal field. When this local field had the proper strength, the presence of 60- to 70-eV electrons flowing from the cathode toward the anode was revealed by special probe measurements. The proton beam traversed the arc column longitudinally from the anode toward the cathode, was focused to a 2- to 3-mm-diameter crossover within the plasma column, passed through the opening in the cathode, and was analyzed with a magnetic spectrometer. When the counterflux of 60- to 70-eV electrons was absent, the energy distribution of the proton beam was broadened by passage of the beam through the plasma only to the same extent as by passage through the unionized gas. In the presence of the counterflux, however, the proton energy distribution was considerably altered; the average energy loss reached 1%, the energy distribution developed a low-energy tail extending to 4 to 5%, and there appeared a small high-energy tail that showed that some of the protons were accelerated by their interaction with the plasma. Under these conditions there were detected oscillations of the plasma over a wide frequency range; these oscillations were strongest (signal/noise ratio, 10 to 20 db; detector sensitivity, 10^{-13} W) in the 50- to 250-MHz region. No oscillations were detected in the 1 to 4 kMHz range corresponding to the Langmuir frequency of the plasma. Variation of the magnetic field strength by a factor of 5 had little effect on the proton beam energy loss, but increase of the gas pressure reduced the energy loss. The failure to observe the expected excitation of the plasma at the Langmuir frequency, which is to be expected even in the absence of the electron counterflux, is ascribed to the short length of the interacting plasma column and proton beam. (ATD)

39125 EFFECTS OF A DYNAMIC GAS ON BREAKDOWN POTENTIAL. Gardner, Jack A. (Jet Propulsion Lab., Pasadena, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1414-15 (July 1968).

An experimental investigation was conducted to determine the influence of gas velocity and pressure on the electrical breakdown potential of argon between parallel flat-plate electrodes. (TSS)

39126 ELECTRICAL CONDUCTIVITY OF A SEEDED NITROGEN PLASMA. Garrison, G. W. (ARO, Inc., Arnold Air Force Station, Tenn.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1264-70(July 1968).

The electrical conductivity of a nitrogen plasma seeded with potassium (in the form of powdered K_2CO_3) was measured experimentally under conditions similar to those present in MHD accelerators and compared with existing theory. By accounting for the nonuniform temperature profile in the flow, reasonable agreement between theory and experiment was found. The nitrogen vibrational mode was equilibrated at the gas temperature and the degree of electron thermal nonequilibrium was found to be small with an energy loss factor of between 50 and 100 indicated for the electron–nitrogen interaction. The free potassium in the gas was determined to be 50% or less of the amount expected based on complete vaporization of the K_2CO_3 added to the gas. This was attributed to incomplete vaporization of the seed and seed condensation on the apparatus walls. (auth)

39127 NONLINEAR EFFECTS IN PLASMA RESONANCE. Hsuan, Hulbert C. S. (Univ. of Iowa, Iowa City). Phys. Rev., 172: 137-45(Aug. 5, 1968).

The problem of interaction between a plasma and radiation is formulated in a self-consistent fashion. The particular nonlinear effect of interest is associated with the possibility of the excitation of a localized electrostatic mode by an externally impinging radiation. The equation for the localized electrostatic mode is found to be intrinsically nonlinear (or anharmonic), and the explicit expressions for the frequency shift and the amplitude jump of the localized electrostatic mode are calculated. (auth)

39128 MEASUREMENT OF VOLUME RECOMBINATION COEFFICIENTS IN HIGHLY IONIZED ALKALI PLASMAS. von Goeler, S.; Motley, R. W.; Ellis, R. (Princeton Univ., N. J.). Phys. Rev., 172: 162-5(Aug. 5, 1968).

The recombination coefficients in highly ionized cesium and potassium plasmas were determined from measurements of the atomic flux emerging from the plasma column. The experiment was performed in the transition region between two-body and three-body recombination, at T = 2500°K and with density between 2×10^{10} cm^{-3} and 2×10^{12} cm^{-3}. The measured recombination coefficients followed the theory due to Bates, Kingston, and McWhirter within a factor of 2. (auth)

39129 WAVE COUPLING ACROSS A SHOCK WAVE IN A FULLY IONIZED GAS. Francis, Samuel H.; Kahn, David (National Aeronautics and Space Administration, Cambridge, Mass.). Phys. Rev., 172: 181-92(Aug. 5, 1968).

A theory is presented for the coupling between electron–acoustic, ion–acoustic, and electromagnetic plane waves at an idealized shock front in a two-fluid, fully ionized, inviscid plasma. The equations of hydrodynamics and Maxwell's equations are used to derive the dispersion equation relating the frequency and propagation constant of possible modes of propagation in a plasma. Boundary conditions which must hold at the shock front in the presence of an incoming perturbation are then derived, and the amplitudes of predicted wave modes generated at the boundary are calculated. A generalized Poynting vector is used to calculate energy coupling ratios for the waves. In agreement with previous work on sound-shock wave interaction in neutral gases, enhanced ion–acoustic transmission is found in the present work. In addition, enhanced propagation is also found in the electron–acoustic coupled mode. (auth)

39130 RECOMBINATION, ATTACHMENT, AND AMBIPOLAR DIFFUSION OF ELECTRONS IN PHOTO-IONIZED NO AFTERGLOWS. Weller, Charles S.; Biondi, Manfred A. (Univ. of Pittsburgh). Phys. Rev., 172: 198-206(Aug. 5, 1968).

Photoionized plasma afterglows of NO were studied by combined microwave and mass-spectrometric techniques. Nitric-oxide–neon mixtures (5 to 65 mtorr NO, 2 to 7 torr Ne) are contained in a 10-cm resonant cavity where they are ionized by a "single pulse" of Lyman-α radiation. A temporal spectrum of ions diffusing to the wall is obtained by a differentially pumped mass spectrometer and multichannel analyzer. Analysis of the electron-density decay curves obtained by microwave techniques to obtain an electron–ion recombination coefficient for NO^+ is complicated by the conversion of NO^+ to the dimer ion, $(NO)_2^+$. At sufficiently low densities of nitric oxide the $(NO)_2^+$ concentration becomes negligible, and the NO^+ wall current tracks the electron-density decay. From comparisons of experimental electron-density decay curves obtained under recombination-controlled conditions, with computer solutions of the electron-continuity equation, the values $\alpha(NO^+) = (7.4 \pm 0.7)$, $(4.1 \pm {}^{0.5}_{0.3})$, and $(3.1 \pm 0.2) \times 10^{-7}$ cm^3/sec, at T = 200, 300, and 450°K, respectively, are obtained. From analysis of electron-density decay curves at higher densities of NO, where $(NO)_2^+$ is the dominant ion, the value $\alpha(NO)_2^+ = (1.7 \pm 0.4) \times 10^{-6}$ cm^3/sec at T = 300°K is obtained. The three-body electron-attachment and ambipolar diffusion coefficients were measured in pure NO (0.1 to 5 torr) and are found to be $K = (1.3 \pm 0.1) \times 10^{-31}$ cm^6/sec and $D_a p = 80 \pm 16$ $cm^2 torr/sec$, respectively, at T = 300°K. (auth)

39131 ATOMNYE STOLKHOVENIYA: ELEMENTARNYE POTSESSY V PLAZME. (Atomic Collisions and Elementary Processes in Plasma). Smirnov, B. M. Moscow, Atomizdat, 1968. 380p.

Nuclear particle collisions and processes taking place in low-temperature plasma are reviewed. The analysis includes plasma in gas discharges, gas lasers, MHD-generators, thermoelectric converters, and other systems. Processes related to upper atmosphere physics and astrophysics are also discussed. A brief review is given of the theoretical and experimental data on elementary processes in ionized gases. (R.V.J.)

39132 SELF-TRAPPING AND INSTABILITY OF HYDROMAGNETIC WAVES ALONG THE MAGNETIC FIELD IN A COLD PLASMA. Taniuti, T. (Nagoya Univ., Japan). Phys. Rev. Lett., 21: 209-12(July 22, 1968).

The self-trapping and the modulational instability of nonlinear

hydromagnetic n waves of right-hand polarization in a cold plasma are discussed on the basis of a nonlinear dispersive equation, which enables one to directly apply the results obtained in the nonlinear optics. (auth)

39133 OBSERVATIONS OF NONLINEAR DAMPING OF TONKS–DATTNER RESONANCES. Decker, J. F.; Mendel, C. W. Jr. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett., 21: 206-9(July 22, 1968).

A strong decrease in the damping of Tonks–Dattner resonances with increasing strength of the exciting microwave field has been observed in low-pressure mercury and argon dc discharges. Order-of-magnitude estimates indicate that a nonlinear effect involving a balance between wave–particle and particle–particle collisions may be responsible. (auth)

39134 VORTICES AND WAKES IN LOW-SPEED, THERMAL PLASMA FLOWS. Mironer, Alan. Syracuse, N. Y., Syracuse Univ., 1967. 299p.

Thesis.

The theoretical part of the research is an analysis of an isolated, heat-conducting, compressible, variable transport property and composition "pseudo-rectilinear" vortex. This real gas vortex is called "pseudo-rectilinear" because a radial velocity must be present due to the combined effects of heat conduction and compressibility. As time passes, there occurs in the vortex a simultaneous, coupled diffusion of heat, mass, and vorticity. The analysis consists of simultaneous numerical solutions (using finite difference techniques on a digital computer) of the fluid heat conduction, continuity, and Navier–Stokes equations. The only restriction on the fluid motion is axial symmetry and two-dimensionality. The experimental part of the research uses a radio frequency plasma generator to heat a uniform, laminar, low speed air plasma free jet. Various diameter cooled cylinders are placed across the streaming plasma jet. The freestream Reynolds number of the jet is varied over a wide range by changing the plasma flow velocity (mass flow rate) and cylinder diameter. The flow structure downstream of the cylinder is studied using shadow and schlieren optics. (TSS) (Disser. Abstr.)

39135 AREA WAVES IN A THETA PINCH. Newton, A. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 8: 93-7(May 1968). (CLM-P-152).

Measurements made in the mid-plane of the theta pinch plasma indicate a sudden decrease in line density. This is interpreted as the arrival of a rarefaction wave due to axial plasma loss. Detailed predictions of density, and β given by an axial MHD computation, are in good agreement with the observations. (auth)

Production of Plasma

39136 PASSAGE OF ELECTRIC CURRENT THROUGH A FAST-MOVING PLASMA IN AN INDUCTIVE HYDRODYNAMIC SHOCK TUBE. Rotkhardt, L. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 24-8(1967). (In Russian).

The effect of an inductive hydrodynamic shock tube in producing a fast-moving plasma without distributed currents is explained. The plasma source consists of a plain cylindrical glass chamber surrounded by a coil. Results of measurements of the conductivity between the cold electrodes in a moving plasma are given. When the longitudinal conductivity is measured in an expansion tube, data on precursors can be obtained. In measuring transverse conductivity, two isolated branches are observed in the volt–ampere characteristic, which can be explained by boundary phenomena. Experimental measurements of the potential distribution in plasma between cold electrodes with current passage can give more complete information on the physical situation in moving plasma. (ATD)

39137 APPARATUS USING LASERS TO TRIGGER THERMONUCLEAR REACTIONS. Whittlesey, John R. B. U. S. Patent 3,378,446. Apr. 16, 1968. Filed Mar. 9, 1964.

Apparatus for substantially instantaneous heating of a test particle is proposed comprising: a means for defining an hermetically sealed test chamber; means for evacuating the chamber; a plurality of lasers focused in balanced arrangement upon a reaction point within the chamber; a fall-directing barrel communicating with the top of the chamber; a test pellet supporting seat of magnetic material; a means adjacent the barrel for creating a magnetic field for holding the pellet supporting seat within the barrel and then releasing it for free fall of the pellet along a path intersecting the reaction point; and a means responsive to the passage of the particle through a trigger point above the reaction point in the path of free fall, for energizing the lasers and then firing them simultaneously so as to apply their beams to the particle symmetrically, whereby to apply balanced pressures to the particle to effect the substantially instantaneous heating. (Offic. Gaz.)

Stability of Plasma

39138 (COO–1695-10) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 5. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). June 15, 1968. Contract AT(11-1)-1695. 18p. Dep. CFSTI.

The electron cyclotron resonance device was operated to obtain additional free–free bremsstrahlung measurements, plasma diamagnetism, energetic electron flux and electron density in the discharge. The brush cathode gun was operated as a PIG discharge. Aluminized, scintillators were placed in the axial and radial directions in the vacuum chamber. Radio frequency emission from the plasma was observed. An instability in the operation of the device was observed. Theoretical work is under way to determine the nature of this instability as well as a new method for evaluating the eigenfrequencies of a microwave cavity filled with a plasma of variable density. (M.O.W.)

39139 (MIAPH-PL-68.3) VARIATIONAL APPROACH TO THE DYNAMIC STABILITY OF HIGH-DENSITY PLASMAS IN MAGNETIC CONTAINMENT DEVICES. Wells, Daniel R.; Norwood, Joseph Jr. (Miami Univ., Coral Gables, Fla. Dept. of Physics). Revised June 1, 1968. 53p. Dep. CFSTI.

Variational methods are used to determine the structure of dynamically stable plasmoids. The total energy of the plasmoid is varied subject to a set of constraint integrals on the flow. It is demonstrated that the resulting flow structure results in a plasmoid of the type observed experimentally when the angular momentum of the plasmoid is not conserved. This is the collinear vortex structure. New experimental results are presented which demonstrate that the structures observed in mirror trapping experiments may be of the type predicted by the variational calculation. (auth)

39140 (N-68-17428) MACROSCOPIC QUASILINEAR THEORY OF THE GARDEN HOSE INSTABILITY. Davidson, Ronald C.; Voelk, Heinrich J. (California Univ., Berkeley). Jan. 1968. 17p. (NASA-CR-93155). CFSTI.

For Massachusetts Inst. of Tech., Cambridge.

The quasi-linear stabilization of the gardenhose instability is discussed from a macroscopic point of view with closure in the fluid model obtained by neglecting the effects of heat flow. In order to keep the problem well posed mathematically finite Larmor radius corrections to the conventional growth rate are retained, which leads to a natural cut off in the growth rate for sufficiently large wave number. (auth) (STAR)

39141 EFFECT OF A HIGH-FREQUENCY MAGNETIC FIELD ON PLASMA INSTABILITIES. Ivanov, A. A.; Rudakov, L. I.; Teikhmann, I. Zh. Eksp. Teor. Fiz., 54: 1380-91(May 1968). (In Russian).

The effect of a high-frequency magnetic field $H_\sim$ on the oscillations of a plasma confined by a stationary magnetic field H_0 is studied. It is shown that already a relatively weak field strength $H/H_0 \sim (mT_i/MT_e)$ is sufficient to suppress cone, drift-cone, and cyclotron instabilities. The drift and drift-temperature instability increments can be decreased at $H/H_0 \sim \rho_i/a$ (ρ_i is the Larmour ion radius and a is the plasma radius). (auth)

39142 EFFECT OF TOROIDAL MAGNETIC FIELD ON LOW-FREQUENCY PLASMA INSTABILITIES IN A MULTIPOLE MACHINE. Bhadra, D. K. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 171: 188-93(July 5, 1968).

The effect of a finite toroidal field on the low-frequency instabilities occurring in a nonuniform plasma inside a multipole machine was investigated. It was found that the flute-type drift-cyclotron mode is stabilized by the introduction of a very small amount of toroidal field. Also, an unstable universal-cyclotron mode was investigated for finite $k_{||}$. These results, obtained by using a numerical solution on the Univac 1108 digital machine were found to be in good agreement with the findings of a recent experiment. (auth)

39143 GRAVITATIONAL INSTABILITY OF A PLASMA. Bhatia, P. K. (Univ. of Jodhpur, India). Nuovo Cim., 56B: 23-8(July 11, 1968).

Using a modified Chew–Goldberger–Low equation (C.G.L. equation), the problem of gravitational instability of a plasma was studied. The dispersion relation was obtained for the case of wave propagation along the magnetic field. It is found that

Jeans' criterion still determines the gravitational instability. (auth)

39144 LARMOR RADIUS AND COLLISIONAL EFFECTS ON THE COMBINED TAYLOR AND KELVIN INSTABILITIES IN A COMPOSITE MEDIUM. Hans, H. K. (Univ. of Delhi). Nucl. Fusion, 8: 89-92(May 1968).

The simultaneous effects of ion Larmor radius and collisions with neutral atoms are investigated on Kelvin–Helmholtz and Rayleigh–Taylor configurations. It is found that the Kelvin configuration is stable if both finite Larmor radius effects and the collisions are taken into account for all wave-numbers greater than the critical value $U/2\nu$. When the system is unstable, it is found that, whereas the Larmor radius has a stabilizing influence, a collision frequency has a stabilizing effect when it is small and a destabilizing effect when it exceeds a certain value. In the case of the Rayleigh–Taylor configuration it is found, however, that the collisions have a stabilizing influence. (auth)

Thermonuclear Processes

39145 METHOD AND APPARATUS FOR PRODUCING NUCLEAR-FUSION REACTIONS. Farnsworth, Philo T. (to International Telephone and Telegraph Corp). U. S. Patent 3,386,883. June 4, 1968. Filed May 13, 1966.

A method and apparatus are described for producing controlled nuclear-fusion reaction by use of self-generated electric fields and inertial ionized-gas containment. The apparatus comprises a spherical anode which concentrically surrounds a cathode. A plurality of ion guns are mounted on the exterior of the anode in spherically spaced and diametrically aligned relationship such that the beam axes intersect at the center of the cathode. Appropriate apertures are provided in the cathode for passage of the ions. Other apertures permit passage of positively charged particles outwardly from the cathode interior, but are biased negatively to prevent the flow of electrons into the interelectrode space. A voltage is applied between the anode and cathode. Ions from the guns are propelled and focused into the center of the cathode establishing in the cathode interior a series of concentric spherical sheaths of alternating maxima and minima potentials called "virtual electrodes." The ions in the innermost "virtual electrode" have fusion energies, and are contained at a density sufficient to produce a self-sustained fusion reaction. (Offic. Gaz.)

Shielding

Refer also to abstracts 38261, 38651, 39303, and 39555.

39146 (UNC–5179) AIRTRANS: A TIME-DEPENDENT MONTE CARLO SYSTEM FOR RADIATION TRANSPORT IN A VARIABLE DENSITY ATMOSPHERE AND THE GROUND. Cohen, M. O. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). June 1967. 92p. Dep.

A detailed description is given of AIRTRANS, a three-dimensional FORTRAN Monte Carlo system. The time-dependent transport of primary neutrons and primary and secondary gamma rays both in an atmosphere whose density is dependent on height and in the ground is described. The radiation field is expressed as the time- and energy-dependent flux at a maximum of 50 point or horizontal ring detectors in the atmosphere. The systems calculates uncollided fluxes analytically and collided fluxes by the "once-more-collided flux-at-a-point technique. (M.H.R.)

39147 PROBLEMS IN THE SHIELDING AND MEASUREMENT OF ELECTROMAGNETIC AND NUCLEAR CASCADES, WHICH WERE PRODUCED BY ELECTRONS OR PHOTONS OF VERY HIGH ENERGY. Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg). pp 1823-9 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In German).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

For shielding calculations or dosimetry problems concerning electrons or photons in the GeV region it is necessary to have a summary description of the interaction of these particles with matter. The electromagnetic and the nuclear cascade initiated by these particles are described. It is shown which characteristics result from known experimental and theoretical studies, and the cascades produced by 6-GeV electrons are given as an example. The principles of dosimetry of these radiations are reviewed briefly and illustrated by two examples. (auth)

39148 SHIELDING OF SOLAR CELLS AGAINST VAN ALLEN BELT PROTONS. Carosella, Carmine A. (Naval Research Lab., Washington, D. C.). J. Spacecraft Rockets, 5: 878-80(July 1968).

A computer program for calculating the lifetimes of solar cells exposed to Van Allen belt protons is described. The program takes into account the alteration of the differential flux spectrum of the particles by the shielding material and is applicable to all proton energies. The calculated life in space as a function of shield thickness is shown for an n-on-p silicon solar cell. (A.G.W.)

39149 APPLICATION OF THE PERTURBATION THEORY TO CALCULATION OF γ-RADIATION'S PENETRATION THROUGH TWO-LAYER BARRIER. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaveb., Fiz., No. 3, 77-82(1968). (In Russian).

Gamma radiation penetration through two-layer barrier was calculated for the case when the second layer is quite small. In such event its influence can be considered as a perturbation. By various transformations in the perturbation operator the integral term is excluded. This helps to find, analytically, the differential relation between angle and energy of γ radiation behind the two-layer barrier with the non-perturbed flux behind the first layer. The formula obtained was used for calculating accumulated dosage factor behind the two-layer lead/water barrier. The results obtained are in good agreement with published data. (tr-auth)

Solid-State Physics

Refer also to abstracts 37786, 38134, 38173, 38182, 38776, and 39027.

39150 (AD–668468) FAST RECOVERY OF ELECTRON IRRADIATED GERMANIUM. Report No. Scientific-1. Bourgoin, J.; Baruch, P. (Paris Univ. (France). Laboratoire de Physique). Jan. 15, 1968. Contract F61052-67-C-0002. 14p. (AFCRL–68-0213). CFSTI.

The fast recovery of electron concentration after a burst of 1-MeV electrons (1 mA during 15 microsec) has been studied near 100°K, in high-purity n-type germanium (10^{13} to 3×10^{13} Sb/cc). Three different stages have been observed: (1) a fast decrease (10 microsec) of excess carrier concentration; (2) a further decrease below the initial concentration, during 6 msec, which can be attributed to filling of traps either created by irradiation or grown in the crystal; (3) a return towards the initial concentration through defect annealing. The time constant, at 100°K, is 24 msec, and the activation energy, near 100°K, is 0.14 eV. This stage appears negligible below 60°K, as expected if it corresponds to the "65°K defect." This behavior can be interpreted with a model based on the creation of a transient defect, stabilized by electronic capture, and then decaying by the usual annealing process. (auth) (USGRDR)

39151 (AD–668469) LOW-TEMPERATURE IRRADIATION AND ANNEALING OF N-TYPE GERMANIUM; EFFECTS OF OPTICAL BLEACHING. Report No. Scientific-1. Zizine, J. (Paris Univ. (France). Laboratoire de Physique). Jan. 15, 1968. Contract F61052-67-C-0002. 16p. (AFCRL–68-0214). CFSTI.

The isothermal recovery of n-type germanium after irradiation by electrons at 20°K is studied by electric conductivity measurements around 65°K. This study shows that the reaction involved in this temperature range is a diffusion-controlled recombination of strongly correlated pairs, thus indicating close vacancy–interstitial pairs. The isochronal recovery of n-type germanium after irradiation by electrons at 20°K is studied by Hall effect and resistivity measurements. Results are discussed. (auth) (USGRDR)

39152 (AD–668470) PHOTOCONDUCTIVITY SPECTRA OF LOW-TEMPERATURE ELECTRON-IRRADIATED GERMANIUM. Report No. Scientific-3. Fischer, J. E.; Zizine, H.; Cherki, M. (Paris Univ. (France). Laboratoire de Physique). Jan. 15, 1968. Contract F61052-67-C-0002. 13p. (AFCRL–68-0215). CFSTI.

Photoconductivity spectra of n-type germanium irradiated at 4 and 20°K have been measured. Optical quenching phenomena associated with a level at 5.8 microns have been observed in a pure sample doped with 3×10^{13} Sb/cc irradiated at 4°K with a dose of 5×10^{14} e/cm^2 of 1.5 MeV. This quenching phenomena disappeared after 90°K annealing. (auth) (USGRDR)

39153 (BNL–12596) THE PHONON DISPERSION RELATION FOR HCP ^{4}He WITH A MOLAR VOLUME OF 21.1 cm^3. Kitchens, T. A.; Minkiewicz, V. J.; Lipschultz, F. P.; Shirane, G.; Nathans, R. (Brookhaven National Lab., Upton, N. Y.). [1967]. 4p. (CONF-680808–1). Dep. CFSTI.

From Conference on Low Temperature Physics, St. Andrews, Scotland.

The classical Born–von Kármán theory of lattice dynamics fails to predict stable lattice vibrations (phonons) in the ^{4}He hcp phase. This failure is due to the dominant role played by the zero-point motion in crystalline helium; at low molar volumes of ^{4}He, the amplitude of the zero-point motion is approximately ⅓ of the nearest neighbor distance and the zero-point energy is more than 95% of the total energy. The first direct observation of phonons in oriented hcp ^{4}He single crystals are reported and compared with the numerical calculations by Gillis, Koehler, and Werthamer. (TSS)

39154 (COO–1197–30) DIFFUSION OF VACANCIES AND VACANCY PAIRS IN NaCl. Nelson, Vaughn C.; Friauf, Robert J. (Kansas Univ., Lawrence). June 1968. Contract AT(11-1)-1197. 4p. (CONF-680902–2). Dep. CFSTI.

For Presentation at International Symposium on Color Centers in Alkali Halides, Rome, Italy.

The results reported here indicate that bound vacancy pairs make appreciable contributions to diffusion of both cations and anions. In order to determine defect contributions the following experiments were performed on single crystals of NaCl: (a) the ionic conductivity was measured in the extrinsic and intrinsic ranges (275 to 797°C) with an ac bridge at 1000 Hz; (b) the diffusion of Na was measured (640 to 790°C) with radioactive tracers and the sectioning method; and (c) the drift mobility of Na tracers was measured (600 to 772°C) by applying an electric field during diffusion, and two check points (692°, 773°C) were obtained with Cl tracers. (M.H.R.)

39155 (COO–1533–7) STUDY OF INTERACTIONS BETWEEN f-SHELL TRANSITION IONS IN NON-METALLIC CRYSTALS. Annual Technical Progress Report, October 1, 1967–June 1, 1968. (Michigan State Univ., East Lansing. Dept. of Physics). June 15, 1968. Contract AT(11-1)-1533. 15p. Dep. CFSTI.

Progress on a project concerned with the interactions between ions in lanthanide and actinide salts, especially those arising from exchange and leading to magnetic ordered states, is reported briefly. Some illustrative data on local fields at chlorine nuclei in $GdCl_3$ are included. Cell parameters for compounds known to be isomorphic to YCl_3 are tabulated. Results of a search for quadrupole resonances in rare earth trichlorides and mixed rare earth–alkali metal halide compounds are shown briefly. (A.G.W.)

39156 (INP–590/PL) SHORT REVIEW OF SOME MOESSBAUER EFFECT EXPERIMENTS FOR IMPURITY ATOMS. Bara, J.; Hrynkiewicz, A. Z. (Institute of Nuclear Physics, Krakow (Poland)). Feb. 1968. 19p. (CONF-670971–1). Dep.

From Conference on the Moessbauer Effect, Varna, Bulgaria.

The paper contains a short review of the experimental results of the Debye–Waller factor and isomer shift measurements for impurity atoms. The experimental data for the Debye–Waller factors might be described theoretically in the Debye approximation of the crystal lattice, under the assumption that force constants for the host-impurity atoms are almost the same as for host–host atoms. Interesting correlations between the isomer shifts for impurity atoms and various properties of solids are pointed out. (auth)

39157 (N–68–13368) IRRADIATION OF HIGH-PURITY ALUMINA. Gregory, T. L. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). June 5, 1967. Contract NAS3-2544. 79p. (NASA-CR–72334; GEST–2101). CFSTI.

In-situ measurements of electrical resistivity and voltage breakdown were performed on cylindrical specimens of high-purity alumina. Eight specimens were irradiated for 1290 hours at temperatures of 800 to 1000°C and received a fast neutron (>1 MeV) dose of 1.4 to 1.6×10^{20} nvt. Data of the pre-irradiation and in-situ electrical measurements are reported and analyzed; the results of the post-irradiation examination of the specimens are presented. (auth) (STAR)

39158 (N–68–17349) AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS. Semiannual Status Report, July 1–December 31, 1967. Compton, W. Dale (Illinois Univ., Urbana. Coordinated Science Lab.). Dec. 31, 1967. Contract DAAB07-67-C-0199. 31p. (NASA-CR–93151). CFSTI.

The microscopic nature of the stable defects formed by the combining or interacting of simple primary defects, vacancies, interstitials, and impurities is investigated. The luminescence arising from the recombination of electrons and holes in silicon irradiated with fast neutrons and gamma rays is discussed. Preliminary measurements of luminescence of unirradiated germanium are mentioned. A discussion is also presented on hole–optical phonon interactions in degenerate silicon in tunneling measurements. It is suggested that the interactions result in modifications in the bulk semiconductor states above and below the Fermi energy. (STAR)

39159 (N–68–17613) INVESTIGATION OF RECRYSTALLIZATION OF THIN FILMS UNDER THE EFFECT OF ELECTRON BOMBARDMENT. Pilyankevich, A. N.; Zakharov, V. P.; Chugaev, V. N. Translated for National Aeronautics and Space Administration, Washington, D. C., from Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 789-92(May 1966). 5p. (NASA-TT-F–10466). CFSTI.

A comparative study was made of the change in structure of thin films of germanium and silicon exposed to electron bombardment and thermal annealing. It was found that the temperature gradient arising during electron irradiation and the motion of the temperature front due to the thermal conductivity of the film results in recrystallization and the formation of large single crystals at thicknesses an order less than those observed by Gilbert et al. It is shown that, in contrast to previously prevailing opinion, recrystallization can occur in covalent crystals in the solid phase. (auth) (STAR)

39160 (N–68–21219) RADIATION DAMAGE IN THICK COPPER AND GOLD SPECIMENS PRODUCED BY LOW-ENERGY PROTONS. Savage, Howard F.; Morris, Robert D. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Apr. 1968. 12p. (NASA-TN-D–4452). CFSTI.

The production of defects at 90°K in thick gold and copper foils by 50- to 400-keV protons and subsequent annealing characteristics of these metals have been studied. The thickness of the specimens was several times the calculated range of the protons. The defects formed in gold were uniformly distributed along the proton range, whereas the defects formed in copper were more than twice as dense toward the end of the range as at the beginning. At doses from 10^{15} protons/cm^2 to at least the maximum of the tests, the change in electric resistivity of both the gold and copper at incident energies between 50 and 400 keV can be described by a relation of the form $\Delta\rho = A\phi^n$, where $\Delta\rho$ is the increase in resistivity and ϕ is the dose. The recovery of gold upon isochronal annealing was similar to that observed for high-energy irradiations of thin specimens. (auth) (STAR)

39161 (NYO–3454–22) THERMAL, STRUCTURAL, AND MAGNETIC STUDIES OF METALS AND INTERMETALLIC COMPOUNDS. Annual Report, May 15, 1967–May 15, 1968. Wallace, W. E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). Contract AT(30-1)-3454. 163p. Dep. CFSTI.

Work in progress is described briefly. Results of completed work on the following are summarized: magnetic and structural characteristics of the pseudobinary systems $TiFe_2$–YFe_2, $ZrFe_2$–YFe_2, and $TiFe_2$–$TiCo_2$; electronic specific heats of alloys of the $TiFe_2$–$ZrFe_2$ and $ZrCo_2$–$ZrFe_2$ systems; and magnetic and crystallographic characteristics of ternary intermetallic compounds of the form $Ln_{1-x}Ln'_xNi_2$. Copies of eight papers accepted for publication in various journals are included, and a separate abstract was prepared for each of these. (A.G.W.)

For abstracts of individual papers see: 39162–39169.

39162 (NYO–3454–22, Paper 1) MAGNETIC CHARACTERISTICS OF EUROPIUM–ALUMINUM INTERMETALLICS. Mader, K. H.; Wallace, W. E. (Univ. of Pittsburgh). 20p.

Bulk magnetic characteristics of $EuAl_2$ and $EuAl_4$ are reported for temperatures ranging from 4 to 300°K and for field strengths up to 20 kOe. To evaluate the influence of electron concentration on the magnetic interactions a series of $Eu_xLa_{1-x}Al_2$ alloys, with x ranging from 0.1 to 0.8, was studied over the same interval of temperature and field strength. Between 50 and 300°K all samples exhibited Curie–Weiss behavior with an effective moment characteristic of dipositive europium. $EuAl_4$, $EuAl_2$, and $Eu_{0.8}La_{0.2}Al_2$ become antiferromagnetic below 20°K, two types of antiferromagnetic order being indicated for the latter two intermetallics. Increasing the electron concentration by replacing Eu with tripositive La alters the interaction from predominantly antiferromagnetic to predominantly ferromagnetic as the electron concentration approaches 9. The change in sign of the interaction occurs at about 8.4 electrons per magnetic atom. $Eu_{0.1}La_{0.9}Al_2$ and $Eu_{0.2}La_{0.8}Al_2$ are ferromagnetic at 4°K with Eu moments of about 5 μ_B per formula unit. Eigenvalues of the spin Hamiltonian are obtained for Eu^{2+} in a site of tetragonal symmetry and used to interpret the saturation moments observed for the ferromagnetic ternaries and the deviations from Curie–Weiss behavior for $EuAl_2$ and the $(Eu,La)Al_2$ alloys. The bulk magnetic properties can be quite successfully accounted for on the basis of an overall (Zeeman-like) splitting of 480°K. (auth)

39163 (NYO-3454-22, Paper 2) MAGNETIC CHARACTERISTICS OF LAVES-PHASE COMPOUNDS CONTAINING TWO LANTHANIDES WITH ALUMINUM. Swift, W. M.; Wallace, W. E. (Univ. of Pittsburgh). 26p.

Magnetic properties are reported for twelve intermetallic systems designated by $Ln_xLn'_{1-x}Al_2$ where Ln and Ln′ are two different lanthanide metals. All compounds have the $MgCu_2$ structure (cubic Laves phase). Emphasis has been placed on the coupling mode at low temperatures to elaborate upon the general nature of the magnetic interactions in these compounds. All the compounds exhibited Curie–Weiss behavior above the transition temperature and had effective moment in good agreement with the $g\sqrt{J(J+1)}$ values for the free ions. The paramagnetic moments indicate that the Ln ions are in the tripositive valence state for all systems except those containing Eu; Eu is dipositive. In the magnetically ordered state spins are observed to couple always ferromagnetically when Ln and Ln′ are both tripositive. Saturation moments in many cases are less than expected from gJ, presumably because of crystal-field quenching effects. $CeAl_2$ is antiferromagnetic below 4°K. Direct exchange is probably the dominant interaction in this compound. $Ce_{1-x}Eu_xAl_2$ ternaries with $x \geq 0.8$ are antiferromagnetic at 4°K. For $0.2 \geq x \geq 0.6$ these ternaries are paramagnetic at 4°K. (auth)

39164 (NYO-3454-22, Paper 3) ON THE MAGNETIC CHARACTERISTICS OF Pr–La AND Pr–Y ALLOYS AND THE NATURE OF ELEMENTAL PRASEODYMIUM AT LOW TEMPERATURES. Wallace, W. E.; Kissell, F.; Segal, E.; Craig, R. S. (Univ. of Pittsburgh). 46p.

Magnetic susceptibilities of Pr and Pr–Y alloys are reported for the temperature range 2 to 300°K and for field strengths (H) up to 21 kOe. The alloys show deviations from Curie–Weiss behavior and a tendency toward temperature-independent susceptibility similar to that exhibited by elemental Pr. χ at 4.2°K for Pr decreases sharply with alloying; its Weiss constant changes sign with as little as 10% La or Y. χ at 4.2°K is observed to decrease with increasing H above 10 kOe; the decrease is progressively eliminated by alloying with Y or La, and also is not observed at 300°K. The operator equivalent method is used to calculate the energy-level structure and associated magnetic moments for cubic and hexagonal Pr^{+3} ions. Influence of the sixth-order term and H is included. Using standard formulas it is possible to account for the χ versus T behavior for $Pr_{0.5}La_{0.5}$; the overall splittings at the cubic and hexagonal sites are the same as those found by Bleaney for Pr. Extension of the analysis to Pr enables most of its unusual characteristics to be understood. Appearance of spontaneous magnetization is predicted at T_c, where T_c is calculated to be in the range 24.4 to 32°K, depending on the choice of the molecular field coefficient. This compares favorably with 25°K observed by neutron diffraction techniques. From the analysis it is also clear why (a) the magnetic ordering in Pr is only a weakly cooperative process and (b) order is confined to the hexagonal sites. The new concept of Pr represents a way of harmonizing the two seemingly contradictory models used earlier in describing its low-temperature magnetic behavior. (auth)

39165 (NYO-3454-22, Paper 4) MAGNETIC AND CRYSTALLOGRAPHIC CHARACTERISTICS OF $(Pr,La)Al_3$, $(Pr,Y)Al_3$, $(Pr,La)Al_2$ AND $(Pr,Y)Al_2$. Mader, K. H.; Segal, E.; Wallace, W. E. (Univ. of Pittsburgh). 39p.

Magnetization data are reported for $PrAl_2$ (cubic) and $PrAl_3$ (hexagonal) and ternary alloys in which Pr is partially replaced by Y and La. Between 50 and 300°K Curie–Weiss behavior is observed with slopes as expected for tripositive Pr. The cubic alloys exhibit Curie temperatures ranging from 38.5°K for $PrAl_2$ to 5°K for $Pr_{0.05}La_{0.95}Al_2$. $Pr_{0.05}Y_{0.95}Al_2$ is the single exception; it remains paramagnetic to 4°K. The hexagonal alloys all develop Van Vleck paramagnetism at low temperatures. The operator equivalent method is employed to obtain eigenfunctions, eigenvalues, and magnetic moments for the crystal field states for Pr^{+3} in both the cubic and hexagonal environments. Fourth- and sixth-order interactions are included in both instances and the second-order term is also included for $PrAl_3$ since its axial ratio is not ideal. Susceptibility–temperature behavior of $PrAl_3$ and the hexagonal ternaries can be accounted for with two sets of parameters, which concern the relative importance of the second-, fourth-, and sixth-order interactions; in each case the overall splitting is about 120°K. The maximal value of the overall splitting for the cubic alloys is established to be 25°K. Using a molecular field approach it is possible to understand the development of ferromagnetism in $PrAl_2$, which occurs despite the lack of a permanent moment for Pr in its ground state. With this approach T_c is calculated to be 39°K, which is in excellent agreement with experiment, 38.5°K. The same approach gives a reasonably satisfactory accounting for the composition dependence of T_c and the saturation moment. (auth)

39166 (NYO-3454-22, Paper 5) MAGNETIC CHARACTERISTICS OF LANTHANIDE–ALUMINUM COMPOUNDS. Mader, K. H.; Wallace, W. E. (Univ. of Pittsburgh). 15p.

Susceptibilities (χ) for α Ce_3Al (hexagonal) are presented for the temperature range 4 to 870°K and for β Ce_3Al (cubic), Pr_3Al, Pr_2Al, and $PrAl_4$ for the temperature range 4 to 300°K. These data together with previously published results provide magnetic information for all known Ce–Al and Pr–Al compounds. Magnetization versus field results are also presented for these five compounds for 4, 77, and 300°K. Both forms of Ce_3Al remain paramagnetic to the lowest measured temperatures. Pr_3Al and Pr_2Al are ferromagnetic and antiferromagnetic, respectively, with magnetic ordering temperatures 16 and 18°K, respectively. $PrAl_4$ behaves anomalously; it may be ferrimagnetic below 12°K. Curie–Weiss behavior is observed for temperatures in excess of 100°K. Effective moments deduced from the temperature dependence of susceptibility are in close agreement with $g\sqrt{J(J+1)}$, the value expected for the free tripositive ion. Deviations from Curie–Weiss behavior are noted at low temperatures, originating presumably with the crystal-field interaction. The six known Pr–Al series of compounds show oscillation between ferromagnetic and antiferromagnetic coupling. This is ascribed to the varying electron concentration throughout the series. In keeping with earlier observations the coupling mode for the Pr–Al series seems essentially unaffected by the crystal structure of the compound. (auth)

39167 (NYO-3454-22, Paper 6) MAGNETIC CHARACTERISTICS OF 2-17 LANTHANIDE–NICKEL COMPOUNDS. Carfagna, Paul D.; Wallace, W. E. (Univ. of Pittsburgh). 15p.

Magnetic characteristics of 9 compounds represented by the formula Ln_2Ni_{17} (Ln = Y or a lanthanide) are reported. The Y, Sm, and Lu compounds are ferromagnetic; the others are ferrimagnetic. Curie temperatures range from 601 to 641°K. The nickel moment is 0.27 μ_B, which is in very close agreement with 0.25 μ_B, the value expected if all Ln valence electrons are transferred into the Ni 3d band. Magnetization of the Y_2Ni_{17} and Lu_2Ni_{17} compounds is lost in two stages as temperature is increased. Ferrimagnetism of heavy lanthanide compounds is indicated by the magnitude of their saturation moments and the form of the magnetization–temperature curves. The magnetic coupling is the same as that observed in similar and related Ln–Co and Ln–Fe compounds; i.e., the Ln–Ni coupling is antiferromagnetic and ferromagnetic for heavy and light lanthanides, respectively. From the Curie temperature it is inferred that the Ni–Ni interaction is dominant. This is in contrast with the situation in Ni-containing Laves and Haucke phases, in which the Ln–Ln interaction is dominant. (auth)

39168 (NYO-3454-22, Paper 7) MAGNETIC CHARACTERISTICS OF $CeAl_3$ AND $CeAl_4$. Mader, K. H.; Swift, W. M. (Univ. of Pittsburgh). 16p.

The magnetic properties of hexagonal $CeAl_3$ and orthorhombic $CeAl_4$ between 2.2 and 300°K are reported and discussed in detail. Both of these compounds exhibited deviations from Curie–Weiss behavior at low temperatures. These deviations are attributed to a combination of crystal-field and exchange interactions. Detailed crystal-field calculations are presented for $CeAl_3$, which indicate an overall splitting of 280°K. These calculations take into account the compressed nature of the hexagonal lattice of $CeAl_3$, a feature that introduces a second-order term into the crystalline potential. Using this model and making suitable allowances for exchange interactions, it is possible to compute the susceptibility from Van Vleck's equation. The computed and experimental curves agree within 1% over the entire temperature range. Detailed calculations for $CeAl_4$ are not possible at present because of uncertainties in the crystal symmetry; however, the saturation moment of this compound can be attributed to a large crystal-field interaction, which leaves only the low-lying Kramer's appreciably populated below the transition temperature. (auth)

39169 (NYO-3454-22, Paper 8) STRUCTURAL AND MAGNETIC CHARACTERISTICS OF $TiCr_2$, $ZrCr_2$, $HfCr_2$ AND THE $TiCo_2$–$ZrCo_2$ AND YFe_2–YCo_2 ALLOY SYSTEMS. Abel, Alan W.; Craig, R. S. (Univ. of Pittsburgh). 17p.

The hexagonal modifications of the Laves phases $TiCr_2$, $ZrCr_2$, and $HfCr_2$ all exhibit Pauli paramagnetism with nearly the same susceptibility values ($\approx 4 \times 10^{-4}$ emu/mole). Measurements on the cubic modification of $TiCr_2$ yield a slightly higher Pauli paramagnetic susceptibility (5×10^{-4} emu/mole). The compounds $TiCo_2$ and $ZrCo_2$ form a single-phase pseudobinary system having the cubic Laves-phase structure. The compounds exhibit Pauli paramagnetism with virtually constant susceptibility (1.44 to 1.53×10^{-3} emu/mole) over the entire composition range. The YFe_2–YCo_2 system is also single-phase with the cubic Laves structure. These alloys are ferromagnetic over the entire composition range. As Co is substituted for Fe in YFe_2 the saturation mo-

ment increases, passing through a maximum at the composition $YFe_{1.4}Co_{0.4}$. The striking similarity to the behavior of alloys of elemental Co and Fe is pointed out. (auth)

39170 (UCRL-18126) DENSIFICATION AND ELECTRICAL PROPERTIES OF LEAD ZIRCONIUM TITANATE. Semans, Bruce F. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 37p. Dep. CFSTI.

Thesis.

The effect of Al_2O_3 and Bi_2O_3 on the densification and electric properties of lead zirconium titanate (PZT) solid solution was studied. Samples were hot pressed at 850°C under 18,000 psi for two hours. Al_2O_3 was shown to form a low-melting liquid with PbO that had minimal effect on the densification rate and electric properties. The $PbO-Al_2O_3$ liquid segregated into pockets that did not wet the PZT grain. Bi_2O_3 was shown to lower the temperature at which increased densification occurs as well as lower the coercive field, remnant polarization, and saturation polarization as compared to the undoped material. Although Al_2O_3 was found to segregate, no conclusions on the role of Bi_2O_3 in enhancing the densification process could be made. (auth)

39171 PENETRATION CHARACTERISTICS OF ENERGETIC IONS IN MONOCRYSTALLINE TARGETS AND CHANNELING DIODES OF p-i JUNCTIONS. Kanaya, Koichi (Electrotechnical Lab., Tokyo); Shimizu, Keizo; Ishikawa, Yoshimitsu. Denki Shikensho Iho, 32: 280-92(1968).

For an energetic charged particle, a primary, slowing down in a crystal lattice of a target, by applying the large angle quasi-elastic scattering theory for the random component and the periodic momentum approximation classical scattering theory for the channelled one, expressions are obtained for the fraction of an ion beam transmitted through a target, the rate of energy dissipation with depth, and the backscattering coefficient. The proposed scattering and energy loss model is found to be in good agreement with the experiment. It is shown that the argon ion bombardment with a moderate velocity induced apparently type conversion and junction formation in silicon due to bombardment damages. The "channeling diode" made by channeling effects without any annealing and thermal diffusion processes is of great value for possible device use in integrated circuits. (auth)

39172 DISLOCATION RELAXATIONS IN NIOBIUM SINGLE CRYSTALS. Amateau, M. F.; Gibala, R.; Mitchell, T. E. (Case Western Reserve Univ., Cleveland). Scr. Met., 2: 123-8(Feb. 1968).

The effect of work hardening on characteristics of the Bordoni peak in single crystals of niobium is described. All measurements were made on specimens cut from two single crystals, whose orientations are given. Specimens were deformed in tension at room temperature using a strain rate of $\sim 4 \times 10^{-4}$ sec^{-1}. Stress-strain curves are included. Internal friction measurements were made by a two-component resonant-bar technique at frequencies of about 100 kHz in the temperature range of 80 to 300°K. The α peak was found to be at about 220°K in specimens cut from both crystals. The results are discussed at length. (M.H.R.)

39173 NEGATIVE RESISTANCE DUE TO IMPACT IONIZATION IN IRRADIATED GERMANIUM. Wade, Takao; Fukuoka, Yutaka; Arizumi, Tetsuya (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 165-73(July 1968).

When n-type Ge wafers and diodes, fabricated from the same material, are irradiated with a total flux of about 10^{15} electrons/cm^2 at 9 MeV, their V-I characteristics behave normally at room temperature, but at lower temperatures they show sharp breakdown phenomena accompanied with the negative resistance. The onset electric field of breakdown, the critical field E_c is about 950, 450 and 220 V/cm at the temperature of 4.2°, 77° and 220°K respectively, and the sustaining field E_s, the field after breakdown, is nearly a constant of 100 ± 20 V/cm, independent of the temperature. The properties of the irradiated germanium are very similar to those of a cryosar. E_c and E_s are calculated theoretically by applying Kurosawa's theory on the low temperature breakdown in compensated germanium and the experimental results are well explained by his theory. (auth)

39174 MAGNETIC PROPERTIES OF $Zr_{1-x}Ti_xZn_2$, $Zr_{1-x}Y_xZn_2$, $Zr_{1-x}Nb_xZn_2$, AND $Zr_{1-x}Hf_xZn_2$. Ogawa, Shinji (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 25: 109-19(July 1968).

Magnetization measurement has been made on ternary alloys $Zr_{1-x}M_xZn_2$, where M = Ti, Y, Nb and Hf with x up to 0.3, 0.1, 0.2 and 0.33 respectively. The ferromagnetism in $ZrZn_2$ disappears by alloying Y, Nb, and Hf at $x \simeq 0.03$, 0.07, and 0.15 respectively, and Ti alloys are all ferromagnetic. The Curie temperature of Ti alloys increases initially with increasing x, reaching a maximum value of 49°K at x = 0.2, then decreases. The magnetization of ferromagnetic alloys does not saturate up to 80 kOe. The spontaneous magnetization M(0, T) of all ferromagnetic alloys varies with temperature following a relationship, $M(0, T)^2 = M(0, 0)^2[1-(T/T_c)^2]$. The paramagnetic susceptibilities of Ti and Hf alloys follow approximately the Curie-Weiss law, whereas those of Nb alloys do not. The paramagnetic moments of Ti and Hf alloys derived from the Curie constants are nearly constant, having no correlation with the spontaneous magnetization at 0°K. The above experimental results are interpreted on the itinerant model by assuming a sharp peak in the density of states of $ZrZn_2$ at the Fermi energy. (auth)

39175 ELECTRICAL CONDUCTIVITY AND THERMOELECTRIC POWER OF URANIUM MONOSULFIDE NEAR CURIE TEMPERATURE. Furuya, Hirotaka (Tohoku Univ., Sendai). Jap. J. Appl. Phys., 7: 779(July 1968).

Electrical resistivity and thermoelectric power were measured in the temperature region from 100 to 500°K. The specimen preparation is described. The results of the measurement of absolute thermoelectric power show the anomaly at the Curie temperature as well as other galvanomagnetic properties. This behavior is considered to resemble that of a ferromagnetic metal rather than that of a semiconductor. (M.H.R.)

39176 A STUDY OF SOME ELECTRICAL PROPERTIES OF ERBIUM OXIDE. Bhattacharyya, Amrita Lal. Tempe, Ariz., Arizona State Univ., 1968. 102p.

Thesis.

Electric conductivity of ceramic erbium oxide in the temperature range 450 to 1425°C was studied at oxygen pressures between 10^0 and 10^{-6} atm. The same has been studied for a single crystal of erbium oxide between 900 and 1400°C and in the same pressure range. At high temperatures the conductivity behavior of the single-crystal specimen is found to be the same as that of the ceramic ones. Electric conductivity increases with temperature as well as with oxygen pressure, the latter property indicating p-type behavior. The temperature dependence of σ can be described by the relation $\sigma = \sigma_0 e^{-\epsilon/kT}$ where ϵ, the activation energy, decreases with rising temperature. Near 10^0 atm oxygen $\sigma \propto P_{O_2}^{\frac{1}{6}}$ up to 800°C above which $\sigma \propto P_{O_2}^{\frac{1}{5}}$. Below 10^{-1} atm oxygen $\sigma \propto P_{O_2}^{1/m}$, where m increases up to m = 8 with decreasing oxygen pressure. The thermoelectric power Q of ceramic erbium oxide measured in the above pressure range and between 700 to 1400°C has a positive sign, thus agreeing with the observed p-type behavior of conductivity measurements. At high temperatures Q decreases slowly with temperature and increases with decreasing oxygen pressure. The dielectric constant of erbium oxide at optical frequency has been determined from a measurement of refractive index n, and is $K_\infty = n^2 = 5.0$. Up to 300°C the static dielectric constant is found to be $K_0 = 6.29$; above 300°C, K_0 increases with temperature reaching a value of 14.15 at 589°C. The extrapolated value of K_0 at 1227°C (1500°K) is found to be 65. Using the known values of K_0 and K_∞, the coupling constant γ of polaron theory has been calculated for temperatures between 627 to 1227°C. The values of the effective mass ratios estimated from the calculated values of γ vary from 2.21 at 627°C to 2.80 at 1227°C. The carrier concentrations at 727°C (1000°K) vary from 1.982×10^{17} cm^{-3} at 10^{-2} atm oxygen to 1.20×10^{14} cm^{-3} at 10^{-6} atm oxygen. An attempt has been made to explain the observed conductivity behavior in terms of two defect models, the metal vacancies and the anion interstitials. The observed slopes of $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ in the conductivity-pressure isotherms are attributed, according to the theory, to first, second, and third ionizations respectively, of the metal vacancies. Values $\frac{1}{5}$ and $\frac{1}{7}$ of the slopes are attributed to mixed states of ionizations. However, the anion interstitials model can explain the slopes from $\frac{1}{4}$ to $\frac{1}{6}$ only. (Disser. Abstr.)

39177 RADIATION FROM TANGENTIAL SURFACE PLASMONS IN Al. Buerker, U.; Steinmann, W. (Univ., Munich). Phys. Rev. Lett., 21: 143-5(July 15, 1968).

An unoxidized Al surface was irradiated by 50-keV electrons at grazing incidence. A peak in the spectrum of the electromagnetic radiation emitted from the target was found at an energy of 9.7 eV. It was interpreted as radiative decay of the tangential surface plasmon. (auth)

39178 EFFECTS OF GAMMA RADIATION ON SILICON AND SILICON DEVICES. Landis, DeWitt Jr. Stanford, Calif., Stanford Univ., 1967. 113p.

Thesis.

This work is based on the use of the Shockley-Read-Hall (SRH) defect theory to predict bulk radiation damage effects in semiconductor data from materials and devices to obtain information on the SRH defect parameters. The experimental work is limited to room-temperature cobalt-60 gamma irradiation of silicon devices and of boron- and phosphorus-doped crucible-

grown silicon containing $2 - 8 \times 10^{17}$ oxygen atoms/cm^{-3}; the theory is valid for any semiconductor in any radiation environment as is illustrated by examples utilizing data from the literature. A technique is developed for obtaining defect introduction rates and potentials from resistivity measurements made at a series of radiation fluences. In this techique, all irradiations and measurements are made at a single temperature. Two acceptor levels, at $\phi_c - 0.193$ V and $\phi_c - 0.435$ V, were introduced by Co-60 radiation, as were two donors at $\phi_v + 0.213$ V and $\phi_v + 0.448$ V. The precision of these potentials is about 0.002 V. The introduction rates of these levels are determined to about 10% and in order are 3.1×10^{-3}, 1.2×10^{-5}, 2.4×10^{-3}, and 3.9×10^{-5} cm^{-1} (defects-cm^{-3} per photon-cm^{-2}). The levels are assumed nondegenerate, and the results depend on the values used for the band gap and the intrinsic potential. The samples consistently exhibited a small (~1%) increase in carrier concentration at low fluences (LFCR effect) followed by the expected decrease at higher fluences. Two LFCR effect models, a surface model and a bulk model, are considered. The evidence favors the bulk model, which postulates that radiation destroys an initially present, deep-lying, amphoteric defect. The defect potentials and introduction rates are shown sufficient to predict radiation effects on majority carrier devices. Some applications to these devices are given; the importance of impurities and type of radiation is illustrated, and the presence of the LFCR effect in device irradiation data is demonstrated. In a fairly rigorous application of junction recombination theory to bulk gain degradation in transistors, the source of damage is traced to increased recombination through radiation-induced defects in the emitter depletion layer. It is shown why the widely used "damage constant" theory, though based on an erroneous assumption, gives reasonable results. Three functions of the defect SRH parameters are sufficient to predict bulk gain degradation; and irradiation data from two transistors, an npn and a pnp, are adequate to predict gain degradation in all transistors made of similar material in similar environments. The SRH parameter functions are evaluated from data taken on a 2N707 transistor in the Co-60 room-temperature environment; and the results are shown to give good predictions of the gain degradation of other npn transistors exposed to the same environment. (TSS) (Disser. Abstr.)

39179 A PULSE-TECHNIQUE FOR THE DETECTION OF VERY WEAK NMR SIGNALS AND THE MEASUREMENT OF THE NUCLEAR MAGNETIC MOMENT OF ^{187}Os. Schwenk, A. (Univ., Tuebingen, Ger.). Z. Phys., 213: 482-502(1968). (In German).

By a pulse-technique, rf-irradiation and detection of the NMR-signal are separated in time, and therefore generator-noise can be avoided even at very high rf-field-strengths; this leads to the possibility of broadening the NMR-line saturation. Using this pulse-technique, the sample is not only irradiated by one frequency but by a whole spectrum. A simultaneous narrow band detection of all these spectral lines is achieved by a time-averaging-computer and by calculating the Fourier-transform of the signal stored there. Relaxation-times of samples with weak NMR-signals can be measured with this averaging-technique too. The extremely weak and very narrow NMR-line of ^{187}Os in molten OsO_4 was detected without paramagnetic additions; a frequency range of 80 kHz had to be scanned, this was done in 4 hours. The magnetic moment of this nucleus previously known only from optical hyperfine structure measurements was determined: $\mu_{^{187}Os} = (0.06432 \pm 0.00003)\ \mu_N$. (auth)

39180 THEORY OF THE PENETRATION OF FAST PROTONS INTO A SOLID. Yurkov, B. Ya. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 32-8(July 1968).

Translated from Fiz. Tverd. Tela, 10: 47-55(Jan. 1968).

The theory concerning electron penetration, developed by Spencer, which takes into account both energy loss and multiple scattering, is applied to a beam of fast protons having initial energy 6.3 MeV passing through a solid. The distributions as a function of bombardment depth of the mean ionization energy loss and the number of primary displaced atoms in the crystal lattice are calculated for silicon. This last distribution has a form similar to a Bragg curve and differs from a similar dependence affiliated with electron bombardment. (auth)

39181 THERMOELECTRIC POWER AND ELECTRICAL CONDUCTIVITY OF TITANIUM AND ZIRCONIUM MONOCARBIDES IN THE TEMPERATURE RANGE 20 TO 2000°C. Golikova, O. A.; Dzhafarov, E. O.; Avgustinik, A. I.; Klimashin, G. M. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.) 10: 124-6(July 1968).

Translated from Fiz. Tverd. Tela, 10: 168-70(Jan. 1968).

Measurements were made of the electrical conductivity and thermoelectric power of homogeneous titanium and zirconium monocarbides in the temperature range 20 to 2000°C. The experimental data indicated that the monocarbides had semiconducting properties at high temperatures and the forbidden-band width was estimated to be several tenths of an electron volt. (auth)

39182 LUMINESCENCE OF SiC SINGLE CRYSTALS BOMBARDED WITH ELECTRONS, HYDROGEN IONS, AND DEUTERIUM IONS OF ENERGIES UP TO 20 keV. Makarov, V. V.; Petrov, N. N. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.), 10: 154-8(July 1968).

Translated from Fiz. Tverd. Tela, 10: 205-11(Jan. 1968).

The luminescence of 6H SiC single crystals containing various impurities was investigated. It was found that the dependence of the intensity of cathodoluminescence and ionoluminescence on the energy of incident particles was governed by the state of the surface of the samples as well as by their impurity content. Allowance for the influence of the surface recombination and for the energy losses in an inactive layer made it possible to estimate quantitatively the efficiency of formation of electron–hole pairs by ion bombardment. The obtained values of the average energy of formation of a nonequilibrium electron–hole pair were 7.5 ± 2.5 eV for protons and 9.0 ± 3.0 eV for deuterons. Analysis of the dependence of the cathodoluminescence intensity on the energy of incident electrons yielded carrier diffusion lengths whose values ranged from 0.1 to 0.4 μ, depending on the impurities present in a crystal. (auth)

39183 THE SHAPE AND WIDTH OF THE NUCLEAR MAGNETIC RESONANCE SIGNAL IN THE OVERHAUSER EFFECT. Alekseev, B. F.; Sobotkovskii, B. E. (Inst. of Electrical Engineering, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 178-81(July 1968).

Translated from Fiz. Tverd. Tela, 10: 237-42(Jan. 1968).

It is shown that the NMR signal in the Overhauser effect may undergo distortion and sharpening whose extent is determined by the ratio of EPR line width to NMR line width and by the EPR saturation factor. This distortion and sharpening is the less distinct the larger the above ratio and EPR saturation factor. (auth)

39184 CORRELATION OF THE ELECTRICAL AND MECHANICAL PROPERTIES OF IRRADIATED GERMANIUM CRYSTALS. Khainovskaya, V. V.; Edel'man, F. L.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 211-12(July 1968).

Translated from Fiz. Tverd. Tela, 10: 274-6(Jan. 1968).

Crystals of n-type Ge doped with Sb and p-type crystals doped with Ga were irradiated at room temperature with 3.5-MeV electrons, and measurements of microhardness and concentration of charge carriers were made at increasing doses and at various stages of thermal annealing. The increase in microhardness on irradiation was identical in the n- and p-type Ge. The concentration of carriers in the two materials varied in different ways: n-type specimens changed to p-type with increasing dose, while the concentration in p-type Ge scarcely changed. The processes of annealing of the microhardness and concentration of charge carriers take place in approximately the same temperature range, and the activation energy estimated from isochronous annealing is about 1.2 eV in both cases. (A.G.W.)

39185 DEPENDENCE OF THE ISOMERIC SHIFT OF ^{119}Sn NUCLEI IN SnX_4 COMPOUNDS (X = Cl, Br, I, H, Li, Na) ON THE ATOMIC RADIUS OF ELEMENT X. Chekin, V. V.; Vinnikov, A. P.; Burakhovich, I. A. (Physical-Technical Inst. for Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 10: 225-6(July 1968).

Translated from Fiz. Tverd. Tela, 10: 288-90(Jan. 1968).

The isomeric shift of the Moessbauer absorption spectra of the ^{119}Sn nuclei in SnX_4 (X = Cl, Br, I, H, Li, Na) was measured. When the results were plotted as a function of the electronegativity of X, the isomeric shifts of SnH_4, $SnLi_4$, and $SnNa_4$ did not fit the straight line that represents the tetrahalides. When the results were plotted as a function of atomic radius of X, it was found that the isomeric shift depends linearly on the radius and the slope of the dependence is a function of the nature (s or p) of the valence orbital of X. It is concluded that the isomeric shift is due to valence electrons. (A.G.W.)

39186 FORMATION OF DISTURBANCE AREAS IN A FAST-NEUTRON-IRRADIATED SILICON. Novikov, S. R.; Konopleva, R. F. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tekh. Poluprov., 2: 592-4(Apr. 1968). (In Russian).

Formation of disturbed areas in silicon by fast-neutron irradiation was studied using n-type specimens with specific resistance 3 and 20 ohm-cm and p-type specimens with specific resistance 3 ohm-cm. The results show that in both the n- and the p-type silicons there is a reduced mobility of current carriers at small doses of fast neutrons when the number of point defects is small and the scattering factor is not considered. The reduced mobility

is due to the appearance of nonconducting impurities. However, it is concluded that the small quantities of impurities have only a negligible effect on the formation of deformation. Instead it is assumed that the cause is related to the Fermi level inside the disturbed area, which does not coincide with the extreme level obtained during irradiation. Calculations indicate that the extreme position of the Fermi level in the disturbed region is within $-(0.26 \pm 0.05)$ eV from the boundary of the conductance zone. (R.V.J.)

39187 INDUCED MAGNETIC FIELDS AT Gd NUCLEI IN $GdFe_2$ AND Gd. Persson, B.; Blumberg, H.; Bent, M. (California Inst. of Tech., Pasadena). Phys. Lett., 27A: 189-91 (July 1, 1968).

Large magnetic fields at the site of the Gd nucleus are found to be induced by the application of external magnetic fields on $GdFe_2$ and Gd metal. (auth)

39188 A FIELD ION MICROSCOPE INVESTIGATION OF RADIATION DAMAGE IN IRIDIUM BOMBARDED WITH 10-MeV PROTONS. Petroff, Pierre Claude. Berkeley, Calif., Univ. of California, 1967. 102p.

Thesis.

Well annealed iridium specimens were irradiated at 5°K with 10-MeV protons, "in situ" a field ion microscope attached to the 88" cyclotron at Berkeley. Because of the atomic scale resolution of the field-ion microscope, point defects and their clusters were directly observed at the surface and in the bulk of the irradiated specimens. The low-temperature surface damage caused by bombardment with 10-MeV protons was mostly composed of ejected surface atoms. The larger surface damage observed during irradiation with the imaging field applied to the specimen has been related to the lowering in the binding energy of the surface atoms when the electrostatic field is applied to the specimen. The interpretations of the contrast effects associated with some of the observed defects are also discussed in detail. Interstitials have been associated with extra-bright dots popping up to the surface upon an increase of the field applied to the specimen. Pairs of extra-bright dots popping up to the surface have been associated with single interstitials as well as di-interstitials. The annealing behavior of the defects, as observed from the surface changes and the variations in the bulk interstitial concentration, showed that both annealing stages I and III correspond to interstitial migration. However the limitations of the field-ion-microscope technique did not permit a decision as to the existence of two different types of interstitials associated with stage I and stage III. The effects of the irradiation temperature were also investigated. The large voids and dislocation loops observed in the specimens irradiated at room temperature suggested both a vacancy migration process and a different formation mechanism for the damage. (Disser. Abstr.)

39189 APPLICATION OF THE MOESSBAUER EFFECT IN DETERMINATION OF PHASE DIAGRAMS. Howard, Ephraim Manasseh. Davis, Calif., Univ. of California, 1967. 84p.

Thesis.

The use of the Mössbauer effect in determining phase diagrams is evaluated. The nickel–gold system was selected as the basis for this study because it is well known, and corroborative data were obtained by standard x-ray-diffraction techniques. ^{57}Fe was the Mössbauer isotope used. The Mössbauer spectra were obtained for one-phase quenched-in specimens over the composition range from 25 to 100 atom percent nickel, and a temperature range from 4.5 to 700°K. From these spectra, calibration curves were made of the variation in Mössbauer parameters with composition. Mössbauer spectra were then obtained for specimens equilibrated at temperatures in the range from 840° to 1040°K and quenched to retain the two-phase equilibrium composition. The nickel–gold phase diagram obtained with Mössbauer data from the two-phase specimens and the calibration curve made from the one-phase data were in good agreement with x-ray-diffraction measurements and the existing Ni–Au phase diagram. Means for improving the determination of phase boundaries for other systems by use of the isomer shift or other Mössbauer parameters are also discussed. (Disser. Abstr.)

39190 ELECTRON SPIN RESONANCE AND OPTICAL STUDIES OF HYDROXIDE-DOPED SODIUM FLUORIDE; THE EFFECTS OF IMPURITIES ON COLOR CENTER FORMATION. Meistrich, Marvin Lawrence. Ithaca, N. Y., Cornell Univ., 1967. 127p.

Thesis.

The effect of impurities on the room-temperature x-ray coloration of NaF was studied and it was found that the purest samples show almost no color-center formation. The level of color-center formation in these samples was always less than the impurity concentration. Expressed in terms of energy absorbed in the crystal necessary for formation of an F center, a result of 6×10^4 eV/F center was obtained. Thus, the question of whether or not any intrinsic F-center formation mechanism exists in room-temperature-irradiated NaF was raised and analyzed in terms of the difficulty of stabilizing a Frenkel defect. The reasons for the increased F-center production in impure (or doped) samples were considered according to two models, one applicable to the crystals containing predominantly metallic ions and the other to crystals with oxygen impurities. An investigation of the oxygen-containing anions in the NaF lattice was made. The infrared absorption band due to the substitutional OH^- was identified at 3728 cm^{-1} with a width of about 30 cm^{-1} at room temperature. In addition, narrow absorption lines attributed to OH–divalent ion complexes were observed just below 3600 cm^{-1}. The OH^- band in the vacuum ultraviolet region was observed at 8.2 eV. The O_2^- molecule-ion in the NaF lattice has also been observed. This ion was identified by means of its ESR spectrum, which can be observed below 11°K. The resonance of the O_2^- was qualitatively the same as in other alkali halides. The g-tensor was measured and its principal values were essentially $g_{||} = 2.97$ and $g_{\perp} = 1.41$. This variation in intensity of the different ESR lines due to this large g-anisotropy was shown to be consistent with theory. The hyperfine interaction with the ^{17}O nucleus, as well as the linewidths due to unresolved hyperfine interaction with the surrounding nuclei have also been measured. In addition, saturation of the resonance lines and stress reorientation of the O_2^- molecule-ion were investigated. An optical absorption band at 8.8 eV can be assigned to a charge transfer band of O_2^-. However, no optical band in the near ultraviolet or fluorescence could be detected. The ultraviolet transition of the U-center (substitutional hydride ion) has been identified at 8.0 eV. The reactions and changes in state of these impurities upon x irradiation were monitored by the magnetic resonance and optical spectra described above. The OH^- ions were decomposed by the x rays producing O_2^-, U-centers, other forms of interstitial or substitutional hydrogen and oxygen, and halide ion vacancies. The latter were responsible for the enhancement of the color-center formation. In addition the state of oxygen in NaF doped with Na_2O_2 was discussed. The oxygen was probably present as O^{--}. Several unidentified spin resonance patterns always observed in x-irradiated oxygen-containing NaF were studied. Their possible association with color centers or oxygen ions was considered. (Disser. Abstr.)

39191 ESR STUDIES OF LITHIUM BORATE GLASSES AND COMPOUNDS γ-IRRADIATED AT 77°K: EVIDENCE FOR A NEW INTERPRETATION OF THE TRAPPED-HOLE CENTERS ASSOCIATED WITH BORON. Griscom, D. L.; Taylor, P. C.; Ware, D. A.; Bray, P. J. (Brown Univ., Providence). J. Chem. Phys., 48: 5158-73(June 1, 1968).

Five glasses and four polycrystalline compounds of the lithium borate system have been subjected to γ irradiation at 77°K and subsequently examined by ESR techniques at 9.1 and 35 GHz while maintaining this low temperature. The familiar "five-line-plus-a shoulder" spectrum is observed at X band for both the $Li_2O \cdot 4B_2O_3$ compound and the glasses containing ≲25 mole % Li_2O. However, previously unreported structure is noted on the low-field shoulder of the spectrum for the compound. This new structure, like the "five-line" part, is due to a hyperfine interaction with boron. An entirely new spin Hamiltonian having orthorhombic symmetry is proposed to account for the over-all spectrum and is substantiated by successful computer simulations of the experimental line shapes. The spectra observed in the glasses of both low and high lithium oxide contents are also simulated by computer, under the assumption that the ensembles of centers induced in the glasses are characterized by substantial spreads or distributions in certain spin-Hamiltonian parameters. Aside from these distributions, the centers in the low-alkali-oxide glasses are qualitatively the same as those encountered in crystalline $Li_2O \cdot 4B_2O_3$. There are at least two inequivalent paramagnetic sites in the latter material: for site I the parameters are found to be $A_1 = 12.2$ G, $A_2 = 14.4$ G, $A_3 \approx 7$ G, $g_1 = 2.002$, $g_2 = 2.010$, and $g_3 \approx 2.035$, with the other site(s) differing principally in the values of g_3 and A_3. Analyses of the g and hyperfine tensors for site I show the unpaired spin to be located in a boron–oxygen π system; the hyperfine interaction is with a three-coordinated boron and the oxygen is one that is shared between the latter boron and a boron in four coordination. Most of the centers exhibiting boron hyperfine structure observed in alkali borate materials are probably of this same fundamental nature. (auth)

39192 HALL EFFECT AND CONDUCTIVITY IN THE NEODYMIUM–HYDROGEN SYSTEM. Heckman, Richard C. (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 48: 5281-2(June 1, 1968).

Measurements of electric conductivity and Hall effect at 200°C are reported for neodymium hydrides as a function of composition. The fact that the metallic conduction tends toward zero as hydrogen content increases from NdH_2 to NdH_3 suggests that the conduc-

tion band is being filled. As the composition approaches NdH_3 the Hall coefficient is positive, reflecting hole conduction in a nearly filled band, and increases, reflecting a decrease in the number of free holes. These results are consistent with a protonic hydrogen model in which the hydrogen contributes an electron to the system's conduction band. (A.G.W.)

39193 EXAMINATION OF DILUTE MAGNETIC ALLOYS BY MEANS OF INELASTIC NEUTRON SCATTERING. Kroo, Norbert. Fiz. Szemle, 18: 166-70(June 1968). (In Hungarian).

The inelastic scattering of slow neutrons by solids represents an excellent tool to study the microdynamics of these solids because the neutrons interact with the phonons and magnons. This method was used for studying magnetic crystals containing impurity atoms and for determining the distortion of the magnon spectrum. The measurements were carried out by means of a time-of-flight spectrometer, using iron-base alloys of the Fe(Mn) and Fe(Er) systems. The maximum in the Fe(Mn) system at about 2.5 $Å^{-1}$ was attributed to the decrease of the magnetic electron density of the Fe atoms surrounding an Mn atom, as compared to other Fe atoms surrounding only Fe atoms. An extensive magnetic perturbation was observed around the Er atoms; this is probably due to polarized conductivity electrons near the impurity. (TTT)

39194 MOESSBAUER EFFECT IN ^{129}I DERIVATIVES OF METHANE. Bukshpan, S.; Sonnino, T. (Israel Atomic Energy Commission, Yavne). J. Chem. Phys., 48: 4442-4(May 15, 1968).

The Mössbauer effect in the 27.8-keV transition of ^{129}I was used to investigate the electronic structure of solid CH_3I, CHI_3, and CI_4. From the quadrupole split spectra observed at 85°K the isomer shift and quadrupole coupling constants were derived. The asymmetry parameter η was found to be 0. The structure of the C—I bond was derived for the three cases.

39195 NMR DOUBLE IRRADIATION CIRCUIT. Hewitt, R. C. (Bell Telephone Labs., Murray Hill, N. J.). Rev. Sci. Instrum., 39: 1066-7(July 1968).

Instrumentation for obtaining NMR double irradiation spectra are described. The major new feature is the use of a time division scheme: the measuring radiofrequency, the irradiating radiofrequency, and the receiver are switched on in turn for short, nonoverlapping intervals, at a repetition rate of a few kHz. (B.G.D.)

39196 BOMBARDMENT OF SILICON MONOCRYSTALS BY POSITIVE INTERMEDIATE-ENERGY CESIUM IONS. Ablyaev, Sh. A.; Mikhaelyan, V. M.; Chirva, V. P. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 93-4(1968). (In Russian).

Data obtained on p-type silicon (specific resistance 0.01 to 2000 ohm-cm) bombarded by cesium ions at 30 keV indicated formation of an inverse 0.5-μ layer. The electric resistance of the surface layer is higher than that of the basic material. The current-carrying layer, measured using the Hall effect, was equal to 10^{18} atoms/cm^3. The rate of silicon dissolution in a fluoric acid was not affected by bombardment but the rate of etching was increased. (R.V.J.)

39197 FARADAY EFFECT AT LOW TEMPERATURES IN TERBIUM ALUMINA SILICATE GLASS. Daybell, Melvin; Overton, W. C. Jr.; Laquer, H. L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Appl. Phys. Lett., 11: 79-81(Aug. 1, 1967). (LA-DC-8831).

The Faraday effect has been studied in a high Verdet-constant terbia–alumina–silicate glass containing 58% Tb_2O_3 by weight at a number of temperatures down to 2.08°K using the 6328 Å light from a helium–neon laser. The glass is found to be antiferromagnetic with a Curie temperature of −1.16°K. At 2.08°K the observed rotation as a function of H/T fits the Becquerel equation $\theta = A \tanh(\mu_e H/kT) + BH$, where μ_e is 3.5 Bohr magnetons. Because of this small Curie temperature the low-field Verdet constant above liquid nitrogen temperatures follows the simple Curie law within experimental error. (auth)

39198 INVESTIGATION OF THE MAGNETIC STRUCTURE OF $ErAl_2$ WITH THERMAL NEUTRONS. Will, Georg (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 23a: 413-16 (Mar. 1968). (In German).

The magnetic properties of $ErAl_2$ have been investigated by neutron-diffraction measurements at 300, 77, and 4.2°K. $ErAl_2$ is ferromagnetic with an additional weak antiferromagnetic peak of unknown origin. The magnetic moment is 8.8 μ_B per Er^{3+}. (auth)

39199 STUDY OF SURFACE CHEMISTRY BY THE MOESSBAUER EFFECT. Hobson, M. C. Jr. (Virginia Inst. for Scientific Research, Richmond). J. Electrochem. Soc., 115: 175C-9C(July 1968).

Applications of the Moessbauer effect technique to the study of chemisorption on surfaces, size measurements on microcrystals, the valence states of surface atoms, lattice dynamics of surface atoms, and the structure of surface layers much more than one atom thick are discussed. It is shown that the effects of chemical shift, electron quadrupole splitting, and magnetic dipole splitting on the Moessbauer spectra give considerable information about surface structures and catalytic activity, and insight to problems where resonance absorption methods may be applied to the investigation of surfaces. (J.H.R.)

39200 TEMPORARY CHANGES IN ELECTRICAL PROPERTIES OF POLYMER DIELECTRICS DUE TO IONIZING RADIATION. Adamec, V. (Cables and Insulating Materials Research Inst., Bratislava). J. Polym. Sci., Part A-2, 6: 1241-53(July 1968).

Measurements of conductivity, permittivity, and dissipation factor on polystyrene, low-density polyethylene, poly(ethylene terephthalate), and polytetrafluoroethylene under irradiation with x rays at exposure rates from 0.004 to 400 R/sec are presented. The radiation-induced anomalous conductivity as well as the induced dielectric loss are interpreted by Maxwell–Wagner polarization due to radiation imbalance in surface layers of the specimen. The nature of radiation-induced steady-state conductivity is also discussed. (auth)

39201 USE OF A CLOSED CYCLE HELIUM REFRIGERATOR FOR MOESSBAUER STUDIES. Wiggins, J. W.; Oleson, J. R.; Lee, Y. K.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Rev. Sci. Instrum., 39: 995-7(July 1968).

A closed cycle helium refrigerator has been used successfully to cool the target and absorbed in Coulomb excitation Moessbauer studies. The refrigerator handles the appreciable power from the beam and may be used at any temperature above 20°K. The most severe problem of mechanical vibration has been solved. (auth)

39202 NUCLEAR MAGNETIC RESONANCE MEASUREMENTS IN PtP_2 AND $PtAs_2$. Jones, E. D. (Sandia Lab., Albuquerque, N. Mex.). Phys. Lett., 27A: 204-5(July 1, 1968).

The ^{31}P, ^{75}As and ^{195}Pt NMR's were observed in PtP_2 and $PtAs_2$. The ^{31}P and ^{195}Pt NMR frequency shifts were found to be temperature-independent. Also reported is the ^{75}As NQR in $PtAs_2$. (auth)

39203 THERMOLUMINESCENCE IN POLY(METHYL METHACRYLATE) γ-IRRADIATED AT 77°K. Fleming, R. J. (Monash Univ., Victoria, Australia). J. Polym. Sci., Part A-2, 6: 1283-96(July 1968).

Isotactic and atactic poly(methyl methacrylate) containing varying amounts of polymerization initiator and chain-transfer additives, and carefully purified radiation-polymerized material, were γ irradiated in the dark at liquid nitrogen temperature. On warming to room temperature at a near-linear rate of 20°K/min, a glow peak having a maximum luminescence intensity at 162 ± 8°K was observed in all samples; an additional peak at 239 ± 7°K was resolved relatively infrequently. Low luminescence yields precluded an investigation of the spectral distribution of the glow peaks. It is shown that the electron traps associated with the lower-temperature peak are most probably the main-chain methyl groups, while the higher-temperature glow peak is tentatively associated with escape of electrons from structural defects in a few small crystalline regions of the samples. It is postulated that, for the peak at 162°K, the trapped electrons combine radiatively with luminescence centers when thermally induced rotational motion of the main-chain methyl groups permits sufficient wave-function overlap. Assuming that methods of glow-curve analysis proposed for inorganic materials are applicable to organics, first-order recombination kinetics and an activation energy of 0.084 ± 0.006 eV are deduced for the intensity maximum at 162°K. This activation energy is in fair agreement with that obtained by Bordoni et al., for an unspecified side-chain motion occurring at similar temperatures, but is only about half the values quoted with some reservations by Powles and by Kawai on the basis of NMR experiments. It was not possible to determine the kinetics of the 239°K peak with certainty, but an activation energy of 0.432 ± 0.085 eV follows from a first-order assumption. The additives present in the samples did not appear to play any significant part as electron-trapping agents; this observation contrasts with some recent work on the visible and ultraviolet absorption spectra of the same materials, which showed a close correlation of additional bands developed following irradiation with the presence of specific additives. (auth)

39204 MOESSBAUER MEASUREMENTS WITH ^{40}K. Tseng, P. K. (Argonne National Lab., Ill.); Ruby, S. L.; Vincent, D. H. Phys. Rev., 172: 249-58(Aug. 10, 1968).

The 29.4-keV γ ray formed in the neutron-capture reaction $^{39}K(n,\gamma)^{40}K$ was studied by use of the Mössbauer effect. Several

potassium compounds were used as the neutron targets, i.e., as γ-ray sources for Mössbauer measurements. The results are: (a) All spectra show a single absorption line at v = 0 whose width is no more than 1.3 times the minimum predicted from the lifetime; (b) the background and the recoilless fraction vary strongly from one case to another; and (c) the quadrupole splitting and isomer shifts are small if not zero. The recoilless fraction was measured as a function of temperature for a KF target. By fitting the results to curves based on a simple theory of diatomic solids, a value for the effective Debye temperature of potassium in these targets was obtained. In order to arrive at a value of $\delta \langle r^2 \rangle / \langle r^2 \rangle$ for the ^{40}K nucleus, four careful center-shift measurements were carried out with K metal at 10°K and KF at 10, 55, and 80°K as targets, and KCl at 80°K as absorber. Comparison of these results with calculations of the thermal shifts based on our determinations of the effective Debye temperatures of the different targets shows that the measured line shifts are mainly due to thermal shifts. The accuracy of the measurements is sufficient to place an upper limit of $\delta \langle r^2 \rangle / \langle r^2 \rangle \leq 5 \times 10^{-4}$ for ^{40}K. (auth)

39205 NUCLEAR MAGNETIC RELAXATION OF ^{19}F IN RARE-EARTH-DOPED LaF_3. Shen, L. (Washington Univ., St. Louis). Phys. Rev., 172: 259-64(Aug. 10, 1968).

Nuclear relaxation times T_1 and T_2 have been measured for ^{19}F nuclei in powdered LaF_3 samples containing Pr^{3+} and Nd^{3+} ions. Resonance frequencies of 15.9 and 30.0 MHz were employed and sample temperatures were between 150 and 800°K. Nominal ion concentrations ranged from 0.1 to 10 at. %. The T_2 data confirm the two-sublattice model proposed by Goldman and Shen. The T_1 data indicate that spin-lattice relaxation arises from both spin diffusion and atomic diffusion to the impurity sites. (auth)

39206 SPIN RELAXATION IN MOESSBAUER SPECTRA OF MAGNETICALLY ORDERED SYSTEMS. Levinson, Lionel M. (Weizmann Inst. of Science, Rehovoth, Israel); Luban, Marshall. Phys. Rev., 172: 268-76(Aug. 10, 1968).

A general formula has been derived for Mössbauer absorption spectra of magnetically ordered systems in the presence of electron spin relaxation. The calculation is independent of any particular model of the magnetic spin system and the result is expressed in terms of magnetic spin correlation functions. The leading nonvanishing terms describing line broadening due to spin fluctuations are evaluated explicitly, and a relatively simple result is obtained for the special case of a scalar spin–spin interaction. Line shapes are in general complex, but can display Lorentzian or Gaussian behavior in certain cases. (auth)

39207 INFLUENCE OF RADIO-FREQUENCY MAGNETIC FIELDS ON THE MOESSBAUER EFFECT IN MAGNETIC ^{57}Co SOURCES. Perlow, Gilbert J. (Argonne National Lab., Ill.). Phys. Rev., 172: 319-24(Aug. 10, 1968).

Experiments are described that demonstrate the destruction of the Mössbauer hyperfine pattern by the action of a radio-frequency magnetic field. Two possible mechanisms for the effect are considered: magnetostriction and domain-wall passage. Calculations make magnetostriction seem unlikely, leaving as the probable cause the fluctuations in the γ-ray energy resulting from the alteration in the direction of the hyperfine field after the passage of a domain wall. This is calculated with the aid of the theory of motional narrowing in NMR and a demonstration by Peshkin of the correspondence between the γ ray and the NMR case. The hypothesis of 180° walls is found to be inadequate, and a less restrictive assumption is needed. (auth)

39208 MOESSBAUER EFFECT FOR ^{57}Fe IN Al_2O_3: EFFECTS OF VARIETY OF HEAT TREATMENTS. Bhide, V. G.; Date, S. K. (National Physical Lab., New Delhi). Phys. Rev., 172: 345-50(Aug. 10, 1968).

The reduction of the Al_2O_3:^{57}Fe system in a hydrogen atmosphere causes the formation of metallic iron clusters yielding hyperfine-split spectra. On firing in air, these clusters are first converted to Fe_2O_3, which subsequently dissolves in the lattice to give Fe^{3+} at the Al^{3+} site. Vacuum firing, however, merely tends to stabilize the Fe^{2+} state in addition to the normal Fe^{3+} state. (auth)

39209 MAGNETICALLY INDUCED QUADRUPOLE INTERACTIONS IN $FeCr_2S_4$. Hoy, Gilbert R.; Singh, K. P. (Boston Univ.). Phys. Rev., 172: 514-19(Aug. 10, 1968).

The effective-field parameters at ^{57}Fe nuclei in the cubic normal spinel $FeCr_2S_4$ have been investigated in the temperature range from 60 to 298°K, using the Mössbauer effect. A nonzero quadrupole interaction appears below the effective-magnetic-field transition temperature (≈172°K). The values of the effective internal magnetic field H, the electric field gradient, and the relative orientation of H with respect to the principal axes of the electric-field-gradient tensor (EFG) are determined as a function of temperature, e.g., at 77°K, H = 202 kG, $\frac{1}{2}e^2qQ = -0.62$ mm/sec, and the asymmetry parameter $\eta = 0.4$. Predictions based on the theory of a magnetically induced quadrupole interaction do not explain the observed spectra. Assuming $H \propto (1 - T/T_N)$ near the critical point, $\beta = \frac{1}{3}$ gives a better fit to the experimental data than $\beta = \frac{1}{2}$. (auth)

39210 ANOMALOUS HALL EFFECT IN SINGLE-CRYSTAL DYSPROSIUM. Rhyne, J. J. (Naval Ordnance Lab., White Oak, Md.). Phys. Rev., 172: 523-9(Aug. 10, 1968).

The "anomalous" or magnetization-dependent contribution to the Hall effect in single-crystal dysprosium has been investigated from 340 down to 4°K. In the paramagnetic region, with H applied along $\langle 11\bar{2}0 \rangle$ directions, the Hall resistivity, defined by $\rho_H \equiv R_0B + R_s4\pi M_y$, is linear in H and exhibits a temperature dependence principally due to that of the magnetic susceptibility. The resulting anomalous coefficient $R_s = -18 \times 10^{-12}$ Ω-cm/G and normal coefficient $R_0 = -0.3 \times 10^{-12}$ Ω-cm/G are both temperature-independent above 190°K. Below the Néel temperature (178°K), the anomalous coefficient changes sign, passes through a maximum near 120°K (where $R_s = +21 \times 10^{-12}$ Ω-cm/G), and decreases essentially to zero at 30°K. The temperature dependence of R_s below 105°K is well represented by the first power of the magnetic (spin disorder) resistivity, ρ_m. Such a dependence is in agreement with the f-spin–s-orbit interaction model due to Maranzana, considering only scattering from the thermally disordered spin system as calculated by Irkhin and Abelskii. The contributions to ρ_H predicted by other mechanisms are evaluated and discussed. The second independent component of ρ_H allowed in hcp symmetry and characterized by H applied along $\langle 0001 \rangle$ was determined in the paramagnetic range. High-temperature values of R_s and R_0 are -23×10^{-12} Ω-cm/G and -3.7×10^{-12} Ω-cm/G, indicating appreciable anisotropy between c-axis and basal-plane components. Results could not be continued into the ordered temperature range, because of the enormous magnetic anisotropy. (auth)

39211 ANISOTROPIC THERMAL CONDUCTIVITY OF ELECTRON-IRRADIATED CdS. Vook, Frederick L. (Sandia Corp., Albuquerque, N. M.). Appl. Phys. Lett., 13: 25-7(July 1, 1968).

Measurements of the low-temperature thermal conductivity of electron-irradiated CdS were made on irradiation and annealing. The measurements show that primary defects move at temperatures as low as 35°K in CdS. After annealing above 60°K, an anisotropic thermal conductivity is developed, which is attributed to the formation of anisotropic phonon scatters. The preferred orientation of the anisotropic defects is along the c axis, and the equilibrium energy difference for reorientation is $\sim 1.5 \times 10^{-3}$ eV. (auth)

39212 NUCLEATION DENSITY AND EPITAXY OF GOLD DEPOSITED ONTO COLOR-CENTERED CLEAVAGE SURFACE OF ROCKSALT. Inuzuka, Tadao; Ueda, Ryuzo (Waseda Univ., Tokyo). Appl. Phys. Lett., 13: 3-4(July 1, 1968).

The vacuum deposition of gold upon the color-centered surface of NaCl produced by x irradiation is described. The increase of nucleation density and the enhancement of (100) parallel orientation are observed. It appeared that these findings in experimental results compared with the phenomena on the normal cleavage surface were attributable to the effects of point imperfections produced. A lowering of epitaxial temperature is also observed. The controlled production of imperfections on the surface by irradiation has a critical effect upon the nucleation and epitaxial growth. (auth)

Theoretical Physics

Refer also to abstracts 38775, 38805, and 39697.

39213 (AD-668099) MODULAR VARIABLES IN QUANTUM THEORY. Final Report, June 1, 1965–May 31, 1967. Aharonov, Yakir; Petersen, Aage (Yeshiva Univ., New York. Belfer Graduate School of Science). Nov. 1967. Contract AF19(628)-5143. 54p. (AFCRL-68-0127). CFSTI.

The non-local aspects of interaction between quantum systems are investigated. These aspects are particularly conspicuous in quantum phenomena without a classical analog, such as the quantum effects of electromagnetic potentials. The study of the potential effect leads to the introduction of a new type of dynamical variables, modular variables, which are suitable to express the physical features of the quantum mechanical nonlocality. The potential effect is reviewed and the question of whether the effect can be described as an exchange of otherwise conserved dynamical quantities is discussed. It is shown that this can be done in terms of modular momentum. Some fundamental properties of

modular variables are investigated. In particular it is demonstrated that for these variables the quantum equations of motion are essentially different from the classical ones, and that modular momentum may commute with modular position. It is shown how the peculiar properties of modular momentum enable us to predict new quantum effects with no classical analog, such as radiationless acceleration of charged particles. The concept of modular energy is introduced and its usefulness is shown by suggesting new interesting quantum effects. The two-slit electron interference experiment is discussed in terms of modular momentum. Some further applications of modular variables are outlined, and the difference between classical and quantum mechanical nonlocality is considered. (USGRDR)

39214 CLUSTER EXPANSION FOR QUANTUM GASES. III. PAIR DISTRIBUTION FUNCTION OF DEGENERATE BOSE SYSTEM. Hara, Hiroaki (Tohoku Univ., Sendai).; Ichimura, Hiroshi; Morita, Tohru. Progr. Theor. Phys. (Kyoto), 39: 907-28(Apr. 1968).

The pair distribution function of a hard-sphere Bose gas is evaluated using a modified cluster expansion formula developed in the preceding papers of this series (H. Ichimura, Prog. Theor. Phys., 31: 528(1964); 37: 484(1967)). The contributions for the pair distribution function are expressed in terms of diagrams, and a partial summation of the chain-type diagrams is carried out. The temperature dependence of the resultant expression is investigated for low temperatures, at short and long distances. The result is compared with the expression for the pair distribution function which has been obtained for a weakly interacting Bose gas. The two- and three-particle distribution functions for a degenerate ideal Bose system are derived. (auth)

39215 MODEL FOR THE MEASURING PROCESS IN QUANTUM THEORY. Haake, F.; Weidlich, W. (Univ., Stuttgart). Z. Phys., 213: 451-65(1968).

A simple model is presented (N two level atoms in interaction with a field mode) which shows explicitly some of the main features of a real quantum mechanical measurement, like the channel structure of the Hilbertspace of the measuring device with respect to macroscopic observables. Especially in its quasi exact and approximate treatment the model accounts for the irreversibility of the motion in the measuring system and for the destruction of the initial state of the measured object during the interaction with the measuring device. (auth)

39216 CALCULATION OF THE CHERENKOV LOSSES BY EXTENDED CHARGE SYSTEMS. Kukanov, A. B.; Il'yushina, E. A. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 67-71(1968). (In Russian).

Studies were made of the Cherenkov–Vavilov radiation of space-extended uniformly charged systems (in particular, volume-charged rotating ellipsoids, and surface-charged spheres and infinitely fine rings) and volume currents moving with a constant speed along the optical axis of a single-axis transparent ferrodielectric. (tr-auth)

39217 CORRELATION FUNCTIONS IN RING-DIAGRAM APPROXIMATION. Isihara, A. (State Univ. of New York, Buffalo). Phys. Rev., 172: 166-72(Aug. 5, 1968).

The singlet and pair correlation functions of particles in quantum-mechanical many-body systems are evaluated in ring diagram approximation; thereby consideration is also given to chain diagrams. The results, expressed in terms of the eigenvalues characteristic of the topologically different diagrams which enter the theory, agree with what we expect from Montroll and Ward's results on the grand partition function. (auth)

39218 OPERATOR RELATIONS IN THE KINETIC THEORY OF CLASSICAL MANY-PARTICLE SYSTEMS. Roesler, F.; Drechsler, K. L. (Deutsche Akademie der Wissenschaften, Leipzig). Phys. Lett., 27A: 231-2(July 1, 1968).

By means of an operator relation the formal solution of the Liouville equation is split up so that the basic equation for the singlet distribution $f_1(r_\alpha, v_\alpha, t)$, according to Severne, follows. (auth)

39219 FINITE TEMPERATURE CORRECTIONS TO THE TRANSPORT COEFFICIENTS OF A NORMAL FERMI LIQUID. Pethick, C. J. (Univ. of Illinois, Urbana). Phys. Lett., 27A: 219-21(July 1, 1968).

Finite temperature corrections to the thermal conductivity and spin diffusion coefficient of a normal Fermi liquid are evaluated using a variational solution of the quasi-particle Boltzmann equation. Comparison of theory and experiment yields an estimate for the Landau parameter F_1^s. (auth)

39220 COHERENT PHONON STATES AND LONG-RANGE ORDER IN TWO-DIMENSIONAL BOSE SYSTEMS. Lasher, Gordon (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 172: 224-9(Aug. 5, 1968).

At any finite temperature, the correlation function $\langle\psi^\dagger(r)\psi(0)\rangle$ of a two-dimensional Bose system is known to approach zero as the separation r approaches infinity. The point of view that superfluid phenomena may still persist in such a system is considered. To describe the low-temperature behavior of a condensed two-dimensional Bose system, we use a coherent-state representation of the low-lying phonon excitations. The expectation of the particle field operator $\langle\psi(r)\rangle$ in a coherent phonon state of the system is shown to be a well-defined function. This function has only small fluctuations in its magnitude and, therefore, it is possible to make the usual arguments for superfluid behavior based on the existence of the condensate wave function. The large phase fluctuations of the function, when the coherent phonon states are collected into the thermal ensemble, give rise to the spatial decay of the correlation function or reduced density matrix $\langle\psi^+(r)\psi(0)\rangle$. It is concluded that two-dimensional Bose systems are superfluid at sufficiently low temperatures, even in the infinite-volume limit. An analogous argument would indicate the possibility of superconductivity in a two-dimensional Fermi system. (auth)

39221 FINITE GEOMETRIES AND IDEAL BOSE GASES. Krueger, David A. (Univ. of Wisconsin, Madison). Phys. Rev., 172: 211-23(Aug. 5, 1968).

It is shown that the lack of condensation in partially finite geometries is not dependent on the use of periodic boundary conditions or the symmetry-breaking technique for a class of independent-particle Bose-gas models. Condensation in an ideal Bose gas in a finite geometry is studied for one-, two-, and three-dimensional systems. Explicit expressions for the chemical potential in terms of the number of particles, the temperature, and the dimensions of the system are obtained by using a contour-integration technique to express sums as integrals plus corrections. Even though there is no true condensation, the range of the reduced density matrix for an ideal Bose gas in a thick slab ($L_1 \times L_2 \times L_3$ with $L_1, L_2 \to \infty$ and $\infty > L_3 >> \lambda_T$ = the thermal wavelength) is found to go from order $\lambda_T T_{cB}/(T - T_{cB})$ to order $L_3 \exp[\frac{1}{2}\sqrt{\pi}\xi_{\frac{1}{2}}(L_3/\lambda_T)[(T_{cB}/T)^{\frac{1}{2}} - 1]]$ as the temperature is lowered through the bulk critical temperature T_{cB}. (ξ_χ is the Riemann ξ function). The range exhibits a spatial asymmetry. The onset of this extremely long-range order is found to be reflected in PVT diagrams and the specific heat in a manner very similar to that in bulk condensation. It is conjectured that in calculations for infinite systems the existence of a long- but finite-range order may be a more relevant criterion for superfluidity and superconductivity than the usual criterion of an infinitely long-range order. (auth)

39222 THEORY FOR TREATMENT OF MANY-PARTICLE SYSTEMS WITH SPIN. Naepfel, H. (Univ., Erlangen, Ger.). Z. Naturforsch, 23a: 562-78(Apr. 1968). (In German).

A system of interacting particles is treated by the methods of quantum mechanics. Among the variables the three Euler angles are introduced which give the orientation of the system as a whole in an inertial frame of reference. This allows an expansion of the Schrödinger eigenfunctions in terms of elements of irreducible representations of the rotation group. This method, originally suggested by Wigner, is extended to include particles with spin. Two- and three-particle systems, one particle having spin ½, the rest being spinless, are treated explicitly. If the two spinless particles are regarded as the core of a nucleus, the spin ½ particle as an extra nucleon, one can compare this "three particle nuclear model" with other nuclear models. It permits calculations of Nilsson diagrams and, compared with other models, a more straightforward adjustment of parameters to empirical data. (auth)

39223 QUANTUM DYNAMICS IN PHASE SPACE. Agarwal, G. S.; Wolf, E. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 21: 180-3(July 15, 1968).

After a brief summary of recently derived general results relating to the mapping of functions of noncommuting operators on functions of c numbers, equations are given which describe the time evolution of the c-number equivalents (phase-space representations) of the density operator and of a Heisenberg operator. The evaluation of time-ordered functions of operators by c-number techniques is also briefly discussed. (auth)

39224 SOLUTION OF QUANTUM-MECHANICAL THREE-BODY PROBLEMS. Ruder, H. (Univ., Erlangen, Ger.). Z. Naturforsch., 23a: 579-96(Apr. 1968). (In German).

For the description of a three-body-system 6 coordinates are introduced which take full advantage of the symmetry properties of the system. The Schrödinger equation in these coordinates is derived. Using rotational and reflection symmetry one obtains a set of l respectively l + 1 coupled differential equations containing only the 3 coordinates of the triangle formed by the 3

masses. Solutions are given for special potentials and arbitrary l. The physical meaning of the differential operators appearing in the equations becomes evident from their application to the solution functions. This leads to a rearrangement of the Hamiltonian in a very transparent form and gives a hint how to get the most effective perturbation expansion. A simple example is worked out. For systems with Coulomb interaction a modification of the method is suggested by physical considerations. The calculation of the ground state energy of the helium atom shows the rapid convergence of the procedure. (auth)

39225 SIMPLE ANALYTIC EXPRESSIONS FOR THE TOTAL BORN APPROXIMATION CROSS SECTION FOR PAIR PRODUCTION IN A COULOMB FIELD. Maximon, L. C. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., B, 72: 79-88(Jan.-Mar. 1968).

The total Born approximation cross section for pair production in a Coulomb field given originally by Racah is used to derive two simple and rapidly convergent analytic expansions for this cross section, one valid for high energies, k, of the incident photon, the other for energies near the threshold. For $k > 4\ mc^2$ the fractional error involved in using the first four terms in the high-energy expansion is $<4.4 \times 10^{-5}$. For $k < 4\ mc^2$ the fractional error committed in using the first five terms of the low-energy expansion is $<1.1 \times 10^{-4}$. The leading terms in these expansions are the well-known high-energy and low-energy limits of this cross section, respectively. (auth)

39226 SOLUTIONS OF THE TIME-DEPENDENT KLEIN–GORDON AND DIRAC EQUATIONS FOR A UNIFORM ELECTRIC FIELD. Myers, Vernon W. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., B, 72: 37-42(Jan.-Mar. 1968).

The time-dependent Klein–Gordon and Dirac equations are solved for the motion of a charged particle in a classical uniform electrostatic field of infinite extent. The elementary solutions have a position dependence of the form $e^{ik\cdot r}$ with the component of k in the field direction varying linearly with time. (auth)

39227 THREE-PARTICLE EFFECTS IN THE PAIR DISTRIBUTION FUNCTION FOR ^{4}He GAS. Jordan, Harry F. (Univ. of Colorado, Boulder); Fosdick, Lloyd D. Phys. Rev., 171: 128-49 (July 5, 1968).

The diagonal elements of the three-particle density matrix for ^{4}He were formulated in terms of Wiener functional integrals in order to compute both that part of the pair distribution function linear in the density and the third virial coefficient. The three-particle interaction energy was taken to be a sum of Lennard–Jones potentials between pairs of particles. Evaluation of the Wiener integrals was carried out by a Monte Carlo sampling technique to yield the pair distribution function and third virial coefficient for temperatures from 273 to 5°K. Comparison of the linear portion of the density expansion of the pair distribution function gave qualitative agreement with experimental values for the pair distribution function in liquid ^{4}He measured by neutron diffraction. The values of the third virial coefficient calculated by this method are consistently smaller than the experimental values and consistently larger than the classical values of this quantity over the given temperature range. (auth)

39228 SOLITONS AND EIGENVALUES OF THE SCHROEDINGER EQUATION. Karpman, V. I.; Sokolov, V. P. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 54: 1568-80(May 1968). (In Russian).

Some of the regularities of formation of stationary solitary waves (solitons) in nonlinear dispersive media which the wave processes can be described by the Korteweg–de Vries equation are investigated. The method for determining the soliton amplitudes may also be employed as a fairly effective method of approximative calculation of the energy levels in a one-dimensional potential well. In the limiting case of a large number of levels the method leads to the results of the quasi-classical theory. The asymptotic solution of the Korteweg–de Vries equation for small values of the parameter β (or large similarity numbers σ) is also considered. (auth)

39229 ONE PARTICLE GREEN'S FUNCTION AND SELF-ENERGY PART FOR FINITE SYSTEMS. Bolterauer, Hannes (Justus-Liebig-Univ., Giessen, Ger.). Z. Phys., 213: 375-83 (1968). (In German).

The properties of a very large but finite system of Fermi particles are compared with those of an infinite one. A representation is given for the self-energy part which enables the discussion of the poles of the Green's function and the distribution function on the Fermi surface. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

39230 (NYO-2262-TB-139) EXPERIMENTAL HIGH-ENERGY PHYSICS. Progress Report of the Research Program. Shapiro, Anatole M. (Brown Univ., Providence, R. I. Dept. of Physics). June 1, 1968. Contract AT(30-1)-2262. 15p. Dep. CFSTI.

A report of high-energy physics experiments in progress and preparation is given. Also the on-line data-collection-and-analysis system and particle beam designs are discussed. (J.F.P.)

39231 STATUS AND PROBLEMS OF HIGH-ENERGY PHYSICS TODAY. Science, 161: 11-19(July 5, 1968).

The review of the status and problems of high-energy physics includes a brief history of the development of this field, its status in various nations, comparison with the 1965 policy and with western Europe, the recommendations of the High Energy Physics Advisory Panel, the relation of program cost to the degree of utilization of facilities, and the effect of budget deficiencies on the character of the work. Also high-energy physics as an educational need, special operating problems in the fiscal year 1968, the SLAC Storage Ring and the Brookhaven Bubble Chamber, and the situation in Western Europe and the USSR are covered. (J.F.P.)

Electromagnetic

Refer also to abstract 39263.

39232 (AD-668169) ASYMMETRIC PHOTOPRODUCTION OF MUON PAIRS OFF HYDROGEN AS A TEST OF QUANTUM ELECTRODYNAMICS. Quinn, Daniel James (Stanford Univ., Calif. High-Energy Physics Lab.). Apr. 1968. Contract Nonr-225(67). 142p. (HEPL-534). CFSTI.

An experiment, performed at the electron linear accelerator, which measured the differential cross section for the asymmetric photoproduction of muon pairs from a hydrogen target, gamma-ray + p to negative-muon + positive-muon + p is described. The negative muon was detected under conditions where the positive muon and proton were nonrelativistic in the laboratory. The experiment was performed as a test of quantum electrodynamics. (auth) (USGRDR)

39233 (ANU-P-407) PROTON PROTON BREMSSTRAHLUNG AT 10.5 MeV. Crawley, G. M.; Powell, D. L.; Rao, B. V. Narasimha (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1967]. 8p. Dep.

The proton proton bremsstrahlung cross section was measured at an incident proton energy of 10.5 MeV. The upper limit of 1.3 $\mu b/st^2$ helps to distinguish between the various calculations at this energy. (auth)

39234 (CERN-68-7(Vol.1), pp 556-70) NEW EXPERIMENTAL RESULTS ON THE PHOTOPRODUCTION OF MESONS. Lohrmann, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)).

Photoproduction at energies above a few GeV is reviewed. The topics considered are the photoproduction of pseudoscalar mesons, the photoproduction of rho mesons, and the vector dominance model. The results presented are from recent experiments. (J.F.P.)

39235 (DESY-68/8) PHOTOPRODUCTION OF MESON AND BARYON RESONANCES AT ENERGIES UP TO 5.8 GeV. Erbe, R.; Hilpert, H. G.; Schuettler, E.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 110p. Dep.

In a study of photoproduction at photon energies between 0.3 and 5.8 GeV in a hydrogen bubble chamber approximately 31,000 events with three, five, or seven outgoing charged particles were analyzed. A survey is given of the experimental procedures and of resonance production in quasi-two-body reactions. The cross sections for the processes $\gamma + p \rightarrow p + \pi^+ + \pi^-$, $\gamma + p \rightarrow p + 2\pi^+ + 2\pi^-$, $\gamma + p \rightarrow p + 3\pi^+ + 3\pi^-$, $\gamma + p \rightarrow p + V$ ($V = \rho^0, \omega, \phi$), $\gamma + p \rightarrow p + \eta$, $\gamma + p \rightarrow p + \chi^0$, $\gamma + p \rightarrow \Delta^{++} + \pi^-$, and $\gamma + p \rightarrow \Delta^0 + \pi^+$ were measured as a function of the photon energy. For reactions $\gamma + p \rightarrow p + \rho^0$, $\gamma + p \rightarrow p + \omega$, and $\gamma + p \rightarrow \Delta^{++} + \pi^-$ the differential cross sections and density matrix elements are given for various intervals of the photon energy. The photoproduction of vector mesons and Δ isobars is discussed in terms of several models. (auth)

39236 (DESY-68/29) SUMMARY OF PHOTOPRODUCTION AND LEPTONIC DECAYS OF VECTOR MESONS. Ting, Samuel C. C. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 18p. (CONF-680428-5). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

Tables and graphs are presented showing data on the photoproduction and leptonic decays of vector mesons. Included are interacting particles, production cross sections, primary energies, mass, width, coupling constants, decay modes, angular distribution, and yields. (J.F.P.)

39237 MEASUREMENTS OF SINGLE π^- AND π^+ PHOTOPRODUCTION AT SMALL MOMENTUM TRANSFERS. Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J.; Wahl, H. (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Rev. Lett., 21: 248-50(July 22, 1968).

Single π^- and π^+ photoproduction from deuterium was measured at gamma energies of 3.4 and 5 GeV and momentum transfers between 0.005 and 0.6 $(GeV/c)^2$. The π^-/π^+ ratio is found to be unity near the forward direction and drops to about 0.3 at larger angles. The data support the existence of a forward peak in π^- photoproduction on neutrons. (auth)

39238 POLARIZATION OF RECOIL PROTONS FROM NEUTRAL PION PHOTOPRODUCTION. Lundquist, David Eugene. Stanford, Calif., Stanford Univ., 1967. 162p.

Thesis.

The polarization of recoiling protons from photoproduction of neutral pions from hydrogen was measured. The experiment covered a range of primary photon energies from 500 to 1000 MeV and range of π^0 cm angles from 55 to 130°. With the good recoil proton angle and energy definition of this experiment, new structure in the energy variation of the 90° cm polarization was seen. In particular, the 90° cm polarization is about 80% in the 650 to 700 MeV region and dips sharply at 900 MeV to almost zero. Also a strong dependence of polarization on cm angle was observed from 600 to 850 MeV. These data were incorporated in phase-shift analyses of meson photoproduction. (Diss. Abstr.)

39239 THE BRANCHING RATIO OF THE η- MESON INTO THREE PIONS. Michael, William Baxter. Berkeley, Calif., Univ. of California, 1967. 47p.

Thesis.

The branching ratio $R \equiv [\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)]$ was determined using a heavy liquid bubble chamber in which η-mesons are produced by a π^- beam at 850 MeV/c. All six gammas of the decay $\eta \rightarrow 3\pi^0 \rightarrow 6\gamma$ are detected with a probability of 0.18. This decay mode is thus experimentally separated from the $\eta \rightarrow \pi^0\gamma\gamma$ mode. The value found for the branching ratio is $R = 0.97 \pm 0.24$. (Disser. Abstr.)

Weak

Refer also to abstracts 39263 and 39349.

39240 (COO-1749-4) AN EXPERIMENT FOR THE STUDY OF THE RADIATIVE $K^+_{\tau 2}$ DECAY MODE TO BE PERFORMED AT THE ZERO GRADIENT SYNCHROTRON, ARGONNE NATIONAL LABORATORY. (Case Inst. of Tech., Cleveland, Ohio). June 9, 1967. Contract AT(11-1)-1749. 21p. Dep. CFSTI.

An experiment is proposed to study the decay $K^+ \rightarrow \pi^+ + \pi^0$ using counters and spark chambers. A determination will be made of whether these events are really $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$ and to what extent the photon is from inner bremsstrahlung. A description of this experiment is given including the experimental arrangement, expected event rate, and background. Also the experimental facilities are discussed. (J.F.P.)

39241 (PURC-2137-3) MEASUREMENT OF THE ENERGY DEPENDENCE OF THE FORM FACTOR IN $K^0_L \rightarrow \pi + e + \nu$ DECAY. Technical Report No. 3. Aronson, Samuel H. (Princeton Univ., N. J. Palmer Physical Lab.). May 14, 1968. Contract AT(30-1)-2137. 127p. Dep. CFSTI.

Thesis.

A wide gap, magnetic field spark chamber spectrometer was used to measure the pion energy dependence of the form factor f_+ in $K^0_L \rightarrow \pi^- + e^+ + \nu_e$ decay (K^0_{e3}). Decays of neutral particles were detected in the 13° beam of the Princeton-Pennsylvania Accelerator, and K^0_{e3} decays were identified by kinematical reconstruction, time-of-flight, and by electromagnetic showers in Cherenkov shower counters. The distribution of events according

to their pion energy in the K_L^0 rest frame was used to determine the energy dependence parameter λ in the form factor $f_+(q^2) = f_+(0)(1 + \lambda q^2/m_\pi^2)$, where $q^2 = M_K^2 + m_\pi^2 - 2E_\pi M_K$. Based on a comparison of the data with the distribution of a Monte Carlo sample of events generated with constant form factor, λ was determined to be $\lambda = +0.020 \pm 0.013$. The data are consistent with the single particle dominance model, where the intermediate state is the K*(890). The results, taken together with the value of λ in K_{e3}^+ decay are consistent with the predictions of the $|\Delta I| = \frac{1}{2}$ rule in semileptonic decays. (auth)

39242 (UCRL-18245) A MEASUREMENT OF THE K^+ BRANCHING RATIOS $K_{\mu 2}^+$, $K_{\pi 2}^+$, K_{e3}^+, $K_{\mu 3}^+$. Dairiki, Ned (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 91p. Dep. CFSTI.

Mesons (K^+) in a separated momentum-analyzed beam were brought to rest in a scintillator target which served as a source point for a broad-range magnetic spectrometer. Pions, muons, and electrons from the various decay modes of the K^+ were identified by range and momentum and a measurement of the relative branching ratios ($K_{\mu 2}^+$, $K_{\pi 2}^+$, $K_{\mu 3}^+$, K_{e3}^+) was made. Using a compiled branching ratio value for the ($\tau + \tau'$) modes of (7.26 ± 0.09)% the resulting values of the branching ratios were: $K_{\mu 2}^+$ (63.4 ± 0.99)%, $K_{\pi 2}^+$ (21.6 ± 0.72)%, $K_{\mu 3}^+$ (3.51 ± 0.80)% and K_{e3}^+ (4.12 ± 0.36)%. The measurement is compared with results of other experiments. (auth)

39243 EXPERIMENTAL DETERMINATION OF Reξ FROM $K_{\mu 3}^0$ DECAY. Helland, Jerome A. (Univ. of California, Los Angeles); Longo, Michael J.; Young, Kenneth K. Contract AT(11-1)-34. Phys. Rev. Lett., 21: 257-60(July 22, 1968).

From measurements of the polarization of muons from $K_{\mu 3}^0$ decay, the average longitudinal component was found to be 0.88 ± 0.25, and the average component in the plane of decay but perpendicular to the muon momentum was found to be 0.369 ± 0.036. From these was determined $Re\xi = -1.75^{+0.8}_{-0.4}$, assuming constant form factors. The behavior of Reξ(0) with varying form factors is discussed. (auth)

39244 EXPERIMENTAL EVIDENCE AGAINST THE EXISTENCE OF STRANGE LEPTONS. Young, Kenneth K. (Univ. of Washington, Seattle); Helland, Jerome A.; Longo, Michael J. Phys. Rev. Lett., 21: 254-7(July 22, 1968).

Arguments based on experimental evidence are presented against the existence of strange leptons, as recently suggested by Weiner. (auth)

39245 STRANGE PARTICLE DECAYS. Willis, William J. (Yale Univ., New Haven). pp 153-74 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

A review is given of recent results on strange particle decays, excluding K_L decays into two pions. Hyperons (Σ^+) and (Σ^-) decay and K decay into three pions are mainly discussed. (J.F.P.)

39246 MEASUREMENT OF THE $K_S - K_L$ REGENERATION PHASE IN COPPER AT 2.5 GeV/c. Bennett, S. (Columbia Univ., New York); Nygren, D.; Saal, H.; Sunderland, J.; Steinberger, J. Phys. Lett., 27B: 239-43(July 8, 1968).

The regeneration phase in copper at 2.5 GeV/c was measured on the basis of the time-dependent charge asymmetry in the K_{e3} mode and found to be $\Phi_f = -(28.8 \pm 4.7)^0$. A new determination based on the regeneration intensity and total cross-section measurements yields $\pm(34 \pm 11)^0$. The combined result is $\Phi_f = -(29.6 \pm 4.2)^0$. (auth)

39247 PRECISE COMPARISON OF π^+ AND π^- LIFETIMES. Ayres, David S. (Univ. of California, Berkeley); Cormack, Allan M.; Greenberg, Arthur J.; Kenney, Robert W.; Caldwell, David O.; Elings, Virgil B.; Hesse, William P.; Morrison, Rollin J. Phys. Rev. Lett., 21: 261-5(July 22, 1968).

A second and more precise experiment was performed at the Lawrence Radiation Laboratory's 184-in. cyclotron to look for any difference in the total lifetimes of π^+ and its antiparticle, π^-. Any observed difference would be direct evidence for a violation of CPT invariance in the weak decay of the changed pion. $\tau_+/\tau_- = 1.000\,64 \pm 0.000\,69$, and thus no evidence for a CPT nonconservation was found. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 39265, 39266, 39267–39269, 39271, 39354, and 39636.

39248 (CERN-68-7(Vol.1), pp 523-36) RECENT EXPERIMENTAL RESULTS ON n–p SCATTERING FROM 6 TO 30 GeV/c. Longo, Michael J. (Michigan Univ., Ann Arbor).

New results are presented from several experiments at the Bevetron and the AGS. A measurement of n + p total cross sections in the 14 to 27 GeV/c region is discussed. These measurements were made with an incident neutron beam. The flux of neutrons transmitted with the target empty and full was measured with a total absorption spectrometer with scintillation counters. The total cross sections are tabulated for various momenta. Also preliminary results are given for the total cross sections for neutrons on nuclei at 27 GeV/c and for cross sections for diffraction scattering n + p from 8 to 30 GeV/c. In the last experiment the scattered neutrons are detected by their interactions in steel-plate spark chambers. (J.F.P.)

39249 (CERN-68-7(Vol.1), pp 580-94) STRUCTURE IN THE ANGULAR DISTRIBUTION OF PROTON–PROTON SCATTERING AT LARGE MOMENTUM TRANSFERS. Allaby, J. V.; Diddens, A. N.; Klovning, A.; Lillethun, E.; Sacharidis, E. J.; Schluepmann, K.; Wetherell, A. M. (European Organization for Nuclear Research, Geneva (Switzerland)).

Data on elastic p + p angular distributions at six momenta between 7 and 12 GeV/c in the angular interval 40 to 90° c.m. are described. The outgoing protons were magnetically analyzed and detected in two counter telescopes in coincidence. The cross sections are shown and tabulated as a function of incoming momenta. (J.F.P.)

39250 (CERN-68-7(Vol.2), pp 262-80) PION, KAON, AND ANTIPROTON PRODUCTION IN THE CENTER OF MASS IN HIGH ENERGY PROTON PROTON COLLISIONS. Akerlof, C. W.; Crabb, D. G.; Day, J. L.; Krisch, A. D.; Lin, M. T. (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics); Ratner, L. G. (Argonne National Lab., Ill.); Edwards, K. W. (Iowa Univ., Iowa City).

A particle production experiment for the purpose of understanding the nature of high-energy proton–proton collisions with large momentum transfers is described. Protons having a momentum of 12.5 GeV/c interact with a liquid hydrogen target. The produced particles are detected by a single-arm spectrometer with scintillation counters and are identified by two threshold gas Cherenkov counters. Cross sections for K^+, K^-, π^+, π^-, and $\bar{p}$ production are given. (J.F.P.)

39251 (COO-1195-125) THE REACTION p p → p p $\pi^+\pi^-$ AT 7.9 GeV/c. Grether, Donald Frank (Illinois Univ., Urbana). 1968. Contract AT(11-1)-1195. 148p. Dep. CFSTI.

Thesis.

The reaction p p → p p $\pi^+\pi^-$ was studied at an incident momentum of 7.9 GeV/c using the 80-inch hydrogen bubble chamber. Approximately 3600 events of the reaction were identified; the cross section was determined to be 2.54 ± 0.13 mb. The reaction is found to be dominated by production of the quasi-three body final state N^{*++} p π^-. A simple one pion exchange model is compared to the data and is shown to give generally good results for invariant mass distributions for the entire final state, and for mass and angular distributions for the quasi-three body state. Discrepancies between the data and the model are found to be primarily associated with enhancements in the N^{*++} π^- or p $\pi^+\pi^-$ mass distributions at about 1425 MeV and 1700 MeV. Examination of the 1425 MeV enhancement indicates an apparent interference process rather than an incoherent sum of one pion exchange background and resonance production; the enhancement could not be identified as the N*(1470), the P_{11} wave resonance of π^-p phase shift analysis. Examination of the $\pi^+\pi^-$ mass distribution gives some indication of production of the ρ meson, but no indication of other $\pi\pi$ resonances. No evidence is found for resonances with baryon number = 2. (auth)

39252 (HASL-192) A MONTE CARLO PROCEDURE FOR CALCULATION OF THE EXTRANUCLEAR CASCADE. Beck, Harold L.; Bennett, Burton G.; O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). June 1968. 12p. Dep. CFSTI.

As a first step toward attacking the problem of the cosmic ray cascade in the atmosphere, a Monte Carlo procedure is devised which is unique in its simplicity in describing the cascade process which, when supplemented by statistical estimation gives results at depths of 1000 g/cm² with a small number of histories. In order to test its validity, results obtained by this method are compared with an analytical solution choosing a cascade model for its solvability which has many of the properties of the extranuclear hadron cascade. (auth)

39253 (ORNL-tr-1538-A) INELASTIC PARTICLE INTERACTION AT HIGH ENERGIES (COMPOSITION AND NUMBER OF SECONDARY PARTICLES). Barashenkov, V. S.; Maltsev, V. M.; Patera, E.; Toneev, V. D. (Joint Inst. of Nuclear Research, Dubna (USSR)). Translated from report JINR-P-2393. 61p. Dep. CFSTI.

The results of many experiments in the high-energy region of $T \geq 1$ GeV where the length of the DeBroglie waves of the colliding particles becomes smaller than their geometric dimensions and they begin to play a significant role in the effects connected with the internal structure of elementary particles, are gathered and analyzed without any preconceived theoretical models. The special case considered is the annihilation of antinucleons. In this case, even when the energy of the impinging antinucleon is very small, a large number of fast secondary particles can be produced. From this standpoint, the annihilation of antinucleons has very much in common with inelastic interactions in the presence of high energies, and the corresponding experimental data at all energies above $T \approx 0$. The basic characteristic of the inelastic interactions selected are a distribution of these interactions according to the number of produced particles and the composition of secondary particles. An important individual case is the probability of three-particle reactions. (J.F.P.)

39254 (ORNL-tr-1956) ANALYSIS OF NUCLEAR INTERACTIONS WITH ENERGIES OF $\geq 10^{12}$ eV BY MEANS OF PHOTOEMULSIONS. Miesowicz, M.; Gierula, T. Translated for Oak Ridge National Lab., Tenn., from report INR-814/VI/PH. 19p. Dep. CFSTI.

Results of an analysis of interactions between nucleons of energies higher than 10^{12} eV and emulsion nuclei in two large emulsion stacks are presented. The main results of the emulsion work are presented from the point of view of the fire-ball model taking into account the possibility of the excitation of the nucleons. (auth)

39255 ANGULAR DISTRIBUTION OF RECOIL NUCLEI IN THE REACTION $^{12}C(p,pn)^{11}C$. Denisov, F. P.; Milovanov, V. P.; Pokrovskii, V. N.; Cherenkov, P. A.; Yutlandov, I. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 954-5(May 1968). (In Russian).

The angular distribution of recoil nuclei in the reaction $^{12}C(p, pn)^{11}C$ at 660 MeV proton energy is measured. The targets 5.5 mg/cm^2 and 100 mkg/cm^2 thick were used. The distribution measured is practically the same in both cases and tends to maximum at $\theta \sim 75°$ in the lab system. (auth)

39256 CROSS SECTIONS OF DEUTERON INTERACTION WITH ^{27}Al NUCLEI AT ENERGY 710 MeV. Borisov, V. S.; Bysheva, G. K.; Goldin, L. L.; Gusev, L. N.; Kondratev, L. N.; Sidorenko, Z. S.; Sukhorukov, S. T.; Tumanov, G. K. (Inst of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 956-60(May 1968). (In Russian).

Total and inelastic cross sections of deuteron interaction with ^{27}Al at energy of 710 MeV are measured. The measurements were carried out with deuterons emitted from the internal CD_2 target of the proton synchrotron by means of a spark chamber used both as a nuclear target and as a detector of interactions. The results obtained are discussed in framework of the optical model for a complex particle with the assumption of a black nucleus. (auth)

39257 $\bar{p}$-p ELASTIC SCATTERING AT 6.9 GeV/c. Kitagaki, T.; Takahashi, K.; Tanaka, S.; Sato, T.; Yamaguchi, A.; Hasegawa, K.; Sugawara, R.; Tamai, K. (Tohoku Univ., Sendai). Phys. Rev. Lett., 21: 175-7(July 15, 1968).

The $\bar{p}$-p elastic scattering at 6.9 GeV/c was studied by the analysis of antiproton film taken by the Brookhaven National Laboratory 80-in. hydrogen bubble chamber. The cross section of the elastic scattering was 14.7 ± 1.5 mb. The angular distribution showed a dip in the region of $-t \approx 0.6$ (GeV/c)^2 and a secondary maximum at $-t \approx 0.8$ (GeV/c)^2. (auth)

39258 FOUR-PRONG ANNIHILATION OF 1.2 GeV/c ANTIPROTONS IN HYDROGEN. I. FOUR-PION FINAL STATE. Donald, R. A. (Liverpool Univ.); Edwards, D. N.; Moore, R. S.; (and others). Nucl. Phys., B6: 174-86(1968).

Approximately 17,000 four-prong annihilations of 1.2 GeV/c antiprotons in hydrogen were analyzed. The cross section for annihilation into four prongs is 31.6 ± 1.0 mb and the partial cross section for the 4π final state 2.9 ± 0.2 mb. The 4π state, which is reported here, shows production of ρ^0, f^0, A_2^+ mesons and an enhancement in the 3π and/or $\rho\pi$ system at the mass of the A_1 meson. The frequencies of various resonance channels were determined. Two-body intermediate states account for 40–60% of the 4π final state. Centre-of-mass angular distributions of the pions are presented. A change in the momentum dependence of the forward-backward asymmetry of the pions is observed at a pion momentum corresponding to the production of $A_2^+\pi^+$. (auth)

39259 ANALYSIS OF INELASTIC PROTON–NEUTRON COLLISIONS AT ENERGIES OF 20 GeV. Takibaev, Zh. S.; Boos, E. G.; Tursunov, R. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Dokl. Akad. Nauk SSSR, 180: 75-7(May 1, 1968). (In Russian).

Following up an earlier study, coherent events were eliminated from consideration and 148 three-beam interactions of 19.8 GeV/c protons with the quasi-free neutrons of an Ilford G-5 type emulsion were selected for closer analysis. The angular distribution of the secondary protons of the incident nucleons in the cms system was found to be strongly collimated in the direction of the axis of the collision; this may be explained either by the one-meson exchange model involving the excitation of only one of the colliding nucleons, or to a model not postulating excitation but with intermediate $\pi\pi$ interaction. The data indicated that the nucleons deviate only slightly from their original direction of travel when the energy losses are high. Differences in the proton distribution are attributed to an overcharge process which accompanies the creation of the heavy-nucleon resonance; the mass of this resonance is estimated at about 5 GeV. (TTT)

39260 YIELD OF SLOW π MESONS FROM NUCLEAR EMULSION. Kostanashvili, N. I.; Lebedevich, G. I.; Nabichvrishvili, D. S. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 50: 327-32(May 1968). (In Russian).

The energy dependence of the ratio of slow π^- and π^+ mesons ($E \leq 11$ MeV) produced by interactions of 9-GeV protons in nuclear emulsions was investigated. The probability of π meson yield is a function of the energy and the magnitude of nuclear interaction potentials. The calculated and experimental curves for mean heavy ($Z = 41$, $A = 93.8$) and mean light ($Z = 7$, $A = 14$) nuclear emulsions are compared. (R.V.J.)

39261 PRELIMINARY ANALYSIS OF 5 GeV/c. ANTIPROTON–NUCLEON INTERACTIONS IN PHOTOGRAPHIC EMULSIONS. Padmavathi, S. V.; Rao, Rukmini; Kamal, A. A. (Osmania Univ., Hyderabad, India). Indian J. Pure Appl. Phys., 6: 154(Mar. 1968).

Preliminary results from an analysis of 204 stars, selected from an unbiased sample and presumed to represent antiproton–nucleon interactions, are presented. Two events are consistent with elastic scattering with free protons and six correspond to charge exchange reactions. The cross section for the inelastic interaction is determined. It is inferred that $\sigma_{pn}^- \approx \sigma_{pp}^-$ at this energy characteristics of nonannihilation events are compared with those of proton interactions at similar energy. (auth)

39262 NEKOTORYE VOPROSY FIZIKI VYSOKIKH ENERGII I KOSMICHESKIKH LUCHEI. (Some Problems in High Energy Physics and Cosmic Rays). Azimov, S. A. Tashkent, Izdatel'stvo "FAN" Uzbekskoi SSR, 1967. 128p.

Nine articles are included on high-energy physics and cosmic radiation. Data are presented on the diffraction picture in proton scattering on complex photoemulsion nuclei at 24 BeV energy. A detailed analysis was made of coherent interaction of 17 BeV protons. Inelastic proton-neutron collisions were investigated in a wide range of energies. Mathematical statistics and relativistic kinematic methods were used in the evaluation and analysis of the above processes. (R.V.J.)

39263 STUDY OF THE EFFECT OF CONNECTED STARS. Zolotov, A. M.; Serebrennikov, Yu. I. (Leningrad Polytechnic Inst.). Yadern. Fiz., 7: 1056-9(May 1968). (In Russian).

The comparison of numbers of the straight lines P(r), connecting the centers of N "cosmic" stars in nuclear emulsion in all possible ways, and of the dispersions of these quantities D[P(r)], with the same quantities obtained in the identical conditions, but for N accidental points, shows their coincidence up to statistical errors. This fact is interpreted as an indication to that the so-called "effect of connected stars" is very probably a false effect due to an incorrect approach to the mathematical treatment of the experimental results. (auth)

39264 LARGE ANGLE p–p ELASTIC SCATTERING. Greco, M. (CNEN, Rome). Phys. Lett., 27B: 234-8(July 8, 1968).

An expression was derived for pp elastic scattering at high energies based on the assumption that the probability that a nucleon will break up decreases at high energies and momentum transfer, together with the Boltzmann's statistical definition for the entropy of a thermodynamical state. Experimental differential cross sections are listed for $t \gtrsim 8$ (GeV/c)^2 in comparison with calculated values. It is concluded that in the region defined, the equation derived provides the most accurate fit to the pp elastic scattering data. (L.B.S.)

Strong (Meson-Induced)

Refer also to abstracts 39236, 39263, and 39354.

39265 (CERN-68-7(Vol.1), pp 60-110) EXPERIMENTAL REVIEW OF THE FORWARD PEAK IN INELASTIC TWO-BODY PROCESSES. Colley, D. C. (Birmingham Univ. (England)).

Recent results on the forward peaks in quasi-two-body reactions are summarized. Only the shapes and sizes of such peaks and the ways in which these properties depend on energy are discussed in detail. A survey of the results, Regge pole interpretation of results, KN and $\bar{K}N$ interactions, πN interactions, nucleon isobar production, s-channel effects, and photoproduction are covered. (J.F.P.)

39266 (CERN-68-7(Vol.1), pp 111-60) BACKWARD PEAKS (EXPERIMENTAL). Derrick, M. (Argonne National Lab., Ill.).

The experimental data on backward peaks in two-body reactions initialed by hadrons are summarized, excluding photon induced reactions and n + p reactions. The optical model interpretation, direct channel resonances, resonance properties from backward scattering studies, high-energy data, Regge pole fits to backward $\pi^+ + p$ and $\pi^- + p$ scattering, inelastic processes involving N and Δ exchange, backward peaks in $K^+ + p$ and $K^- + p$ scattering, and inelastic processes involving S = −1 baryon exchange are considered. (J.F.P.)

39267 (CERN-68-7(Vol.1), pp 161-217) SPIN PHENOMENA IN TWO-BODY COLLISIONS, INCLUDING RESONANCE DECAY (EXPERIMENTAL). van Rossum, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Information about specific production mechanisms contained in final-state polarization is considered. Some features of bubble chamber data on polarization effects and their relation to models for resonance production, and electronics experiments for the study of the mechanism of high-energy collisions are discussed. (J.F.P.)

39268 (CERN-68-7(Vol.1), pp 252-89) TWO-BODY PROCESSES WITH LARGE MOMENTUM TRANSFER. Perl, Martin L. (Stanford Univ., Calif.).

The behavior of two-body processes at momentum transfers large enough to be outside the diffraction peak region are reviewed, excluding the region near 180°. Examples and illustrations are given showing large differences in behavior between different two-body interactions in this region. It is no longer clear that there is a theoretically significant separation between the small and the large $|t|$ parts of a two-body process. Most of the results presented are from the 3.0 to 7.0 GeV/c region. Elastic scattering, inelastic but true two-body interactions, and finally quasi-two-body interactions are discussed. (J.F.P.)

39269 (CERN-68-7(Vol.1), pp 345-79) EXPERIMENTAL ASPECTS OF MANY-BODY COLLISIONS. Czyzewski, O. (Institute of Nuclear Research, Krakow (Poland)).

Bubble chamber experiments are reviewed excluding three-body reactions. Cross sections, general features of many-body processes, the multi-Regge model, the average value of the p_i distribution, nucleon t-distributions, neutrons in the forward hemisphere, and leading mesons are covered. Also discussed are high-multiplicity proton−proton interactions and cosmic ray energies. (J.F.P.)

39270 (CERN-68-7(Vol. 1), pp 537-55) COHERENT PRODUCTION OF MULTIPION FINAL STATES IN π^- INTERACTIONS WITH NUCLEI. (European Organization for Nuclear Research, Geneva (Switzerland)).

The results of the interactions of high-energy hadrons with nuclei studied previously by counters, spark chambers, bubble chambers, and nuclear emulsions are discussed. Primarily, the inelastic interactions and particularly the results obtained in a heavy-liquid bubble chamber are considered. General characteristics of particle production on nuclei, experimental results, selection rules, and cross sections are reviewed. (J.F.P.)

39271 (CERN-68-7(Vol. 1), pp 571-9) HIGH ENERGY $\pi^- - p$, $K^- - p$, AND $\bar{p} - p$ ELASTIC SCATTERING. Rubinstein, R.; Ashmore, A.; Damerell, C. J. S.; Frisken, W. R. (Brookhaven National Lab., Upton, N. Y.); Orear, J.; Owen, D. P.; Peterson, F. C.; Read, A. L.; Ryan, D. G.; White, D. H. (Cornell Univ., Ithaca, N. Y.).

The elastic scattering of π^+ and π^- from protons between 5.9 and 14 GeV/c was measured for cms angles of 135 to 165°; measurements of the elastic scattering of π^-, K^-, and $\bar{p}$ from protons at 5.9 GeV/c for cms angles of 20 to 110° were made and also over a more limited angular range at 7.9 and 9.8 GeV/c. Particles were detected using scintillation counter telescopes and optical spark chambers. Preliminary results for the cross sections of these reactions are shown. (J.F.P.)

39272 (CERN-68-7(Vol.1), pp 599-610) INFLUENCE OF RESONANCE PRODUCTION ON THE PION-PAIR ANGLE-DISTRIBUTIONS IN THE REACTION $\pi p \rightarrow p\,5\pi$. Boeckmann, K.; Drevermann, H. (Bonn Univ. (West Germany). Physikalisches Institut. Kernforschungsanlage, Juelich (West Germany)).

Experimental results obtained from the pion-pair angular distributions of the reaction $\pi + p \rightarrow p + 5\pi$ are summarized. The effect of ρ^0 production on the pion-pair angular distributions is discussed assuming a simple statistical model neglecting interference effects. It is shown that the presence of the meson (ρ^0) leads to an energy dependence of the difference of pion pairs of like and unlike charge which is different from that previously predicted. Also effects by which the presence of the Δ^{++} (1236) may affect the pion-pair angle are investigated. Possible reasons for the observed difference between the asymmetry parameter for pairs of positive pions and that for pairs of negative pions are discussed. (J.F.P.)

39273 (CERN-68-7(Vol.2), pp 114-19) EXPERIMENTAL EVIDENCE FOR MULTIPERIPHERALISM. Zweig, G. (Wisconsin Univ., Madison. Dept. of Physics).

Preliminary experimental evidence for the existence of multiperipheral processes is presented. The reaction considered is $\pi^- + p \rightarrow \pi^+ + \pi^- + \pi^- + p$ reactions at an incident π^- momentum of 25 GeV/c in a hydrogen bubble chamber. Curves showing the multiperipheral amplitude are given. (J.F.P.)

39274 (CERN-68-7(Vol.2), pp 121-34) TWO-BODY FINAL STATES PRODUCED IN K^+-PROTON INTERACTIONS AT 10 GeV/c. (European Organization for Nuclear Research, Geneva (Switzerland)).

The reactions $K^+ + p \rightarrow p + K^{*+}$, $K^+ + p \rightarrow K^0 + N^{*++}$, and $K^+ + p \rightarrow K^{*0} + N^{*++}$ were studied at an incident momentum of 10 GeV/c using 200,000 pictures from a hydrogen bubble chamber exposed to an rf separated beam. Cross sections are given for these interactions. (J.F.P.)

39275 (CERN-68-7(Vol.2), pp 135-49) QUASI TWO BODY REACTIONS IN $\pi^+ d$ INTERACTIONS AT 5.1 GeV/c. Barrier, M.; Laberrigue-Frolow, J.; Mettel, D. (Paris Univ., Orsay(France). Institut de Physique Nucleaire); (and others).

Results concerning quasi two-body reactions $\pi^+ + n \rightarrow p +$ meson resonance in $\pi^+ + d$ reactions at 5.1 GeV/c in a deuterium bubble chamber are presented. These results show that the quasi two-body process is dominant. The $p\rho^0$, pf^0, pg^0, $p\omega^0$, pA_2, and $p(\rho\pi)^+_{I=0}$ reactions are rather well represented by theoretical predictions in the t channel. The presence of depolarized ρ^0 for t values above 3 GeV^2 beyond the diffraction peak is evident and is not yet understood. (J.F.P.)

39276 (CERN-68-7(Vol.2), pp 172-89) K^+p INTERACTIONS AT 13 GeV/c. Berlinghieri, J. C.; Farber, M. S.; Ferbel, T.; Forman, B. E.; Melissinos, A. C.; Slattery, P. F.; Yamanouchi, T.; Yuta, H. (Rochester Univ., N. Y.).

A comparison is made of the characteristics of several relatively uncomplicated final states which are studied in the 12.73 GeV/c $K^+ + p$ interactions. Cross sections, density matrix elements, Dalitz plots, invariant mass and four-momentum transfer are given for the various final states. (J.F.P.)

39277 (CERN-68-7(Vol.2), pp 190-207) FURTHER RESULTS ON $\pi^- p \rightarrow K^0 Y^0$ IN THE FORWARD DIRECTION AT 6, 8, AND 11.2 GeV/c. Bertolucci, E.; Mannelli, I.; Pierazzini, G.; Scribano, A.; Sergiampietri, F.; Vincelli, M. L. (Pisa Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Pisa (Italy)); Caverzasio, C.; Guillaud, J. P.; Holloway, L.; Yvert, M. (Paris Univ., Orsay (France). Institut du Radium).

A spark chamber experiment to measure the $\pi^- p \rightarrow K^0 Y^0$ associated production at high energy was recently completed at the CERN PS. Data were taken at 6, 8, 10, 11.2 GeV/c for the incident π^- momentum. Further results at 6, 8, and 11.2 GeV/c based on ~1100, 1300 and 3000 events (about 60%, 65%, and 90% of the available statistics) respectively selected for the differential cross sections are presented. The sum of the $\pi^- p \rightarrow K^0\Lambda^0$ and $\pi^- p \rightarrow K^0\Sigma^0$ differential cross sections is strongly peaked in the forward direction and can be well fitted, for $|t_{min}| \leq |t| \leq 0.4$ (GeV/c)^2, by an exponential shape e^{at} with a = 8.0 ± 0.5 at 6, a = 7.7 ± 0.5 at 8 and a = 7.8 ± 0.4 (GeV/c)$^{-2}$ at 11.2 GeV/c. The integral over the interval $|t_{min}| \leq |t| \leq 1.01$ (GeV/c)^2 gives 40.5 ± 6 μb at 6, 25.3 ± 4 μb at 8 and 18 ± 3 μb at 11.2 GeV/c, including systematic errors. A comparison is made with previous bubble and spark chamber results and Regge Poles fits. (auth)

39278 (CERN-68-7(Vol.2), pp 226-43) SIX PRONG $\pi^- p$ INTERACTIONS AT 11 GeV/c INCOMING MOMENTUM. Daronian, P.; Daudin, A.; Gandois, B.; Kochowski, C.; Mosca, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Some preliminary results on a partial sample of about 4000 six-prong events produced by negative pions of 11 GeV/c on protons in hydrogen bubble chambers are given. (auth)

39279 (CERN-68-7(Vol.2), pp 244-61) MULTIPRONG EVENTS IN 25 BeV/c $\pi^- p$ COLLISIONS. Elbert, J. W.; Erwin,

A. R.; Mikamo, S.; Reeder, D.; Chen, Y. Y.; Walker, W. D.; Weinberg, A. (Wisconsin Univ., Madison).

An analysis is made of multiprong events produced by 25-GeV/c π^- in a hydrogen bubble chamber, and preliminary results are given. Events with from six to sixteen prongs are measured. Cross sections are given for various numbers of prongs in these interactions. (J.F.P.)

39280 (JINR–P1-3822) OBRAZOVANIE ODINOCHNYKH π^0-MEZONOV V π^+–Xe VZAIMODEISTVIYAKH PRI 2,34 GeV/c. (Production of Single π^0 Mesons in π^+–Xe Interactions at 2.34 GeV/c). Slovinskii, B.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 25p. (In Russian). Dep.

The characteristics of π^0-mesons generated in π^+–Xe interactions at 2.34 GeV/c are investigated. (auth)

39281 (UCRL-18206) A SEARCH FOR A K* BELOW Kπ THRESHOLD. Bland, R. W.; Goldhaber, G.; Hall, B. H.; Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.) Apr. 19, 1968. Contract W-7405-eng-48. 5p. (CONF-680428-3). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

A search was made for the production of a scalar meson (K*) having a mass below the Kπ threshold and decaying predominantly via the K$\gamma\gamma$ mode in meson (K^+) interactions on hydrogen near 1 GeV/c. No evidence was found for its existence, and upper limits were placed on its production cross section. The reaction $K^+ + p \rightarrow K_S^* + p$, $K_S^* \rightarrow K^+ +$ neutrals in a hydrogen bubble chamber was investigated. Distributions of the mass recoiling against the final-state proton at 1200 MeV/c are shown. (J.F.P.)

39282 EVIDENCE FOR NARROW 3π EFFECTS NEAR 960 MeV IN K^-p INTERACTIONS AT 4.6 AND 5.0 GeV/c. Juhala, R. E. (Ames Lab., Iowa); Leacock, R. A.; Rhode, J. I.; Kopelman, J. B.; Libby, L. Marshall; Urvater, E. Phys. Lett., 27B: 257-60 (July 8, 1968).

In an investigation of the final states $K^-\pi^-\pi^+\pi^0 p$ and $K^-\pi^-\pi^+\pi^+ n$ produced in K^-p interactions at 4.6 and 5.0 GeV/c narrow enhancements were observed near 960 MeV in both the $\pi^+\pi^-\pi^0$ and $\pi^+\pi^+\pi^-$ distributions. These structures are strongly associated with the $\Delta(1236)$. Also, there is evidence for a possible $\rho\pi$ decay for these effects. (auth)

39283 OBSERVATION OF THE REACTION $\pi^-p \rightarrow N^{*+}\pi^-$ AT 6 GeV/c. Galloway, K. F.; Alyea, E. D. Jr.; Crittenden, R. R.; Prickett, W. F.; Martin, H. J. Jr. (Indiana Univ., Bloomington). Phys. Lett., 27B: 250-2(July 8, 1968).

In studying a sample of events representing the $\pi^-p \rightarrow \pi^-p\pi^-\pi^+$ reaction with high momentum transfer to the final proton, a nucleon isobar was observed with mass near 1700 MeV decaying into $\pi^+p\pi^-$. (auth)

39284 PION–DEUTERON ELASTIC SCATTERING AT 3.65 BeV/c. Hsiung, H. C.; Coleman, E.; Roe, B.; Sinclair, D.; Vander Velde, J. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 21: 187-91(July 15, 1968).

The elastic scattering cross section of π^+ mesons on deuterium was measured at 3.65 BeV/c. The differential cross section $d\sigma/dt$ is presented out to $-t \approx 1$ (BeV/c)^2 and a comparison is made with the prediction of the constant-phase Glauber formula. The agreement is good except in the region of the (theoretical) minimum at $-t \approx 0.4$. Starting with the Glauber formula, a method is presented to relate this discrepancy to the phases of π-nucleon scattering in this region. (auth)

39285 SEARCH FOR A K* BELOW Kπ THRESHOLD. Bland, Roger W.; Goldhaber, Gerson; Hall, Bronwyn, H.; Trilling, George H. (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 173-4(July 15, 1968).

Glashow and Weinberg recently predicted on the basis of current-algebra considerations that a scalar K* meson may exist, having a mass below Kπ threshold and decaying predominantly via the K$\gamma\gamma$ mode. A search was made for the production of this particle by scattering K^+ mesons from hydrogen near 1 BeV/c. No evidence was found for its existence, and upper limits are set on its production cross section. (auth)

39286 PI–RHO MASS SPECTRUM IN π^-–p INTERACTIONS AT 6.7 GeV/c; SPIN–PARITY ANALYSES FOR A(1200) AND FOR A(1300). Von Krogh, J.; Miyashita, S.; Kopelman, J. B.; Libby, L. Marshall (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Lett., 27B: 253-6(July 8, 1968).

The rho-pion mass spectrum for negative, positive and zero charge has been evaluated in 6.7 GeV/c π^- proton interactions. The enhancement at 1100 MeV is present but is not strongly produced. The A(1300) is produced at a level of 40% above background. Spin-parity as determined by analysis of events in the negative charge state is consistent with 2^+, but other assignments, for example 1^+ or 2^-, cannot be excluded. Spin-parity analyses separately on events in the upper and lower halves of the A(1300) peak give identical results. The A(1200) is produced at a level of 30% above background. Spin-parity analysis prefers exclusion of 0^- and 2^+. (auth)

39287 FOUR AND FIVE BODY REACTIONS IN π^+p INTERACTIONS AT 8.5 GeV/c. Rabin, Monroe Stephen Zane. New Brunswick, N. J., Rutgers–The State Univ., 1967. 90p.

Thesis.

A sample of 15,000 four prong events was measured from 60,000 pictures of π^+p interactions in the 80-inch bubble chamber. The momentum of the incident pion beam was 8.5 GeV/c. Events selected for measurement had a final state proton identifiable on the scanning table using ionization and curvature criteria. The measurements were thus restricted to events with a final state proton of momentum less than or equal to about 1 GeV/c. Those measured events are considered which are consistent with one of the final states $p\pi^+\pi^+\pi^-$ or $p\pi^+\pi^+\pi^-\pi^0$. Little evidence is seen for the existence of the A_1 (mass 1.08 BeV) in the four body final state. In the five body final state the neutral component of the A_2 (mass ~1.28 BeV) is seen to decay into $\pi^+\pi^-\pi^0$ for the first time in π^+p interactions. An isotopic spin assignment of 2 for the A_2 is ruled out by both production and decay of the A_2 in the reaction $\pi^+p \rightarrow N^* \rightarrow \pi p$, $A_2 \rightarrow \rho\pi \rightarrow \pi\pi\pi$. The spin and parity of the A_2^0 are found to be consistent with 2^+, the value previously determined for the charged A_2. (Diss. Abstr.)

39288 STUDY OF Y_1^* RESONANT AMPLITUDES BETWEEN 1660 AND 1900 MeV IN THE REACTION $K^-n \rightarrow \Lambda\pi^-$. Smart, Wesley Mitchell. Berkeley, Calif., Univ. of California, 1967. 76p.

Thesis.

The 25-inch deuterium bubble chamber was exposed to a beam of K^- mesons having laboratory momenta between 815 and 1105 MeV/c. The angular distributions and Λ polarizations in the reaction $K^-n \rightarrow \Lambda\pi^-$ were measured in the cms energy interval 1660 to 1900 MeV. A partial-wave analysis of the angular distributions and polarizations from $K^-n \rightarrow \Lambda\pi^-$ and the total cross section data from $K^-p \rightarrow \Lambda\pi^0$ has yielded information on the quantum numbers, resonance parameters, and SU(3) assignments for four Y_1^* resonances. The spin-parity assignments for $Y_1^*(1765)$ and $Y_1^*(2030)$ were confirmed, and the $Y_1^*(1765)$ mass, width, and $\Lambda\pi$ branching ratio were measured as 1772 ± 6 MeV, 129 ± 17 MeV, and 0.15 ± 0.02, respectively. A tentative spin-parity assignment for $Y_1^*(1660)$ and $Y_1^*(1915)$ was also made. The measurement of the relative signs of the product of the coupling constants, $g^8_{NKY}\, g^8_{\Lambda\pi Y}$ for the four resonant amplitudes has limited their possible assignments to SU(3) multiplets. The $Y_1^*(1765)$ can only be a member of the $\{10^*\}$ or the $\{8\}$ multiplets. If it is a member of the octet, the value of α (the D–F mixing parameter) must be either less than $\frac{1}{2}$ or greater than 1. This SU(3) assignment for $Y_1^*(1765)$ is based on the assumption that $Y_1^*(2030)$ is a member of a $\{10\}$ multiplet. (Diss. Abstr.)

39289 RESONANCE PRODUCTION IN π^+p COLLISIONS AT 7 BeV/c. Slattery, Paul Francis. New Haven, Yale Univ., 1967. 376p.

Thesis.

Collisions of π^+ mesons and protons at an incident momentum of 7 BeV/c were studied using the 80 in. hydrogen bubble chamber at the alternating gradient synchrotron. Those collisions leading to the production of the four multi-pion final states: $\pi^+p \rightarrow p\pi^+\pi^+\pi^-$, $\pi^+p \rightarrow p\pi^+\pi^+\pi^-\pi^0$, $\pi^+p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-$, and $\pi^+p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$, were studied in detail, and the cross sections for each of these processes were found to be 1.94 ± 0.10 mb, 2.45 ± 0.27 mb, 0.390 ± 0.032 mb, and 0.856 ± 0.106 mb, respectively. The production of resonant states in the above channels was also investigated, and the resonance production cross sections for each of the above reactions are presented. The above final states were found to be characterized by copious production of the familiar resonant states (e.g., N*(1238), ρ, f, η, and ω), but by no statistically reliable effective mass signals which would have indicated the production of any new resonant states. Appreciable rates for the associated production of baryon and meson resonant states were found, and the cross sections for the quasi two-body category of such reactions (i.e., $N^{*++}(1238)\,\rho^0$ and $N^{*++}(1238)\,f^0$ in the first reaction, and $N^{*++}(1238)\,\eta^0$ and $N^{*++}(1238)\,\omega^0$ in the second reaction are also presented. (Diss. Abstr.)

39290 ANALYSIS OF THE CASCADE FINAL STATES FROM 4.25 BeV/c K^-p INTERACTIONS. Wolsky, Gilbert. College Park, Md., Univ. of Maryland, 1967. 155p.

Thesis.

The reactions $K^- + p \rightarrow \Xi + K + m\pi$ were analyzed at an incident momentum of 4.25 BeV/c. The experiment was primarily con-

cerned with the study of the strangeness −2 baryon resonances. The data in most cases were consistent with the results obtained at lower energies. A higher mass value was found for the $\Xi^*(1930)$. Evidence was also found for the possible existence of a new T = $^3/_2$ Ξ^* resonance at mass value of 2225 MeV. There was also strong K^* production, the $K^*(890)$ being the only resonance that is produced appreciably in a quasi two-body final state. The two-body and quasi two-body production processes appear to be dominated by baryon exchange. The results for the final state $\bar{\Xi}^-K^+$ were compared to the predictions of the model of Ebel and James. The model was found to be inadequate to describe fully this final state. (Diss. Abstr.)

39291 RESONANCE PRODUCTION IN K^+p INTERACTIONS AT 3.5 BeV/c. Bishop, James Martin. Madison, Wis., Univ. of Wisconsin, 1967. 238p.

Thesis.

An analysis is made of K^+-proton interactions which appear in the two prong plus V^0 topology. The experiment was conducted in the 80-inch hydrogen bubble chamber using an incident beam of 3.5 BeV/c K^+ mesons. The principal analysis is concerned with events of the type $K^+ + p \rightarrow K^0 + (p \text{ or } n) + (1 \text{ or } 2\ \pi\text{'s})$. A search is made for kaon and nucleon resonances. The production and decay processes of the $K^*(890)$ and $N^*(1238)$ are discussed for each reaction. The $K^*(1400)$ is discussed with the determination of its spin-parity as 2^+, isospin as $^1/_2$, and its mass, width, and decay mode. Evidence is presented for the $K^*(1300)$ with discussion of its production and decay processes. The spin and parity of the $K^*(1300)$ are discussed and appear consistent with the proposed values of 1^+. The results of a partial analysis of events with multiple neutrals are also presented, as are the reactions in which multiple strange particles are produced. (Disser. Abstr.)

39292 ASSOCIATED PRODUCTION IN π^-p INTERACTIONS AT 5.5 GeV/c. Moses, Edward Joel. Baltimore, Johns Hopkins Univ., 1967. 135p.

Thesis.

A study was made of states with two strange particles arising from interactions of 5.5 GeV/c negative pions with protons. The experiment was performed using the 80″ liquid hydrogen bubble chamber. Events with zero, two, and four charged prongs were included and cross sections for the final states available in these channels were measured. The only strong resonance production observed was that of $K^*(890)$ but limited statistics precluded ruling out production of other resonant states. Weak evidence was seen in K_1K_1 spectra for the recently reported 1050 MeV state of positive charge conjugation, but there is no evidence in K_1K_2 states for the negative charge conjugation meson. Some indications were found suggesting that low multiplicity final states tend to be produced peripherally. One exception was the final Σ^-K^+, which exhibits small momentum transfers from meson to baryon. This is interpreted as possible evidence for baryon exchange. (Disser. Abstr.)

39293 A STUDY OF THE f^0 (1250) PRODUCED IN THE REACTION $\pi^- + p \rightarrow f^0$ (1250) + n, f^0 (1250) $\rightarrow \pi^- + \pi^+$ AT AN INCIDENT PION MOMENTUM OF 4.16 GeV/c. Peters, Robert Edward. Lafayette, Ind., Purdue Univ., 1967. 90p.

Thesis.

The results of an analysis of 4379 π^-p interactions leading to the final state $\pi^+\pi^-n$ at a negative pion beam momentum of 4.16 GeV/c are presented. Approximately 67% of the total cross section of (2.85 ± 0.07) mb can be accounted for by quasi-two-body reactions: $\sigma(\rho^0 n) = (1.15 \pm 0.05)$ mb, $\sigma(f^0 n) = (0.53 \pm 0.06)$ mb, $\sigma[\Delta^+(1238)\pi^-] = (46 \pm 21)\ \mu$b, $\sigma[N^{*+}(1400)\pi^-] = (102 \pm 18)\ \mu$b, and $\sigma[N^{*+}(1688)\pi^-] = (71 \pm 15)\ \mu$b. Very little evidence is seen for g(1675) or N^{*-}. Particular emphasis is placed on a detailed study of background contributions to the f^0 (1250) decay angular distribution and the negative value obtained in this and other experiments for one of the diagonal elements (ρ_{22}) of the "f^0" density matrix. It is shown that the negative value of ρ_{22} can be attributed to a coherent superposition of the f^0 D-wave and an S-wave background. A possible explanation for the forward-backward asymmetry is also given. (Disser. Abstr.)

39294 DISTRIBUTION OF THE RESIDUAL EFFECTIVE MASS IN π^-p INTERACTIONS AT 17 GeV. Azimov, S. A.; Nikishin, B. K.; Rechitskii, I. V.; Chudakov, V. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 78-82(1968). (In Russian).

Studies were made of the inelastic π^-p interactions with free and quasifree photoemulsion protons. An Ilford G5 emulsion was irradiated with 17.2 GeV/c π^- mesons. Examination of 4 km of tracks of primary particles revealed 86 π^-p interactions with 3 and 5 secondary shower particles (charged pions) and slow recoil protons (gray track). It was found that with a resonance mass M_0 of 3.2 GeV, 70% of the M value is in the range of 2.4 to 3.7 GeV. The data indicate that intra-nuclear motion of nucleon targets can diffuse the resonance peak of the residual effective mass distribution and interfere with the observation of resonances in π^-p collisions. (R.V.J.)

39295 NEGATIVE PION–NUCLEON INTERACTIONS AT 3.85 GeV/c USING NUCLEAR EMULSIONS IN A MAGNETIC FIELD. Beznogikh, G. G.; Shahbazyan, B. A.; Trouskova, N. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B6: 373-89(1968).

The results of the investigation of negative pion-nucleon interactions at 3.85 GeV/c momentum using nuclear emulsions in strong magnetic fields are given. One of the possible causes of asymmetries of e.m. angular distributions of secondaries observed in three-prong events can be coherent production processes on nuclear substructures. (auth)

39296 PION SCATTERING AND THE NEUTRON HALO IN LEAD. Auerbach, E. H. (Brookhaven National Lab., Upton, N. Y.); Qureshi, H. M.; Sternheim, M. M. Phys. Rev. Lett., 21: 162-4(July 15, 1968).

Reanalysis of the 700-MeV $\pi^{\pm}$-Pb inelastic scattering experiment of Abashian, Cool, and Cronin leads to a contradiction with recent suggestions of a neutron-rich surface or "halo" unless one admits neutron distributions with sharp edges and with peaks near the surface. (auth)

39297 MEASUREMENT OF THE BRANCHING RATIO $\omega \rightarrow$ NEUTRALS/$\omega \rightarrow$ TOTAL. Bollini, D.; Buhler-Broglin, A.; Dalpiaz, P.; Massam, T.; Navach, F.; Navarria, F. L.; Schneegans, M. A.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim., 56A: 531-46(July 21, 1968).

The results of a counter experiment on the branching ratio R = $\Gamma(\omega \rightarrow \text{neutrals})/\Gamma(\omega \rightarrow \text{total})$ are presented. The masses of particles produced in the reaction $\pi^- + p \rightarrow n +$ (missing mass) at 2.12 GeV/c were determined with an uncertainty of ±15 MeV by using counter techniques to measure the time of flight and emission angle of the neutrons. Veto counters around the hydrogen target selected neutral decay modes. The peak values of ω/background were 0.4 for the neutral mode and 0.55 for the total decay. Corrections to the experimental value are discussed. The value of the branching ratio was found to be (8.4 ± 1.5)%. This result is compared with various theoretical predictions. (auth)

Particle Interactions and Properties (Theoretical)

General

39298 (CERN–68-7(Vol.2), pp 1-23) REGGE RESIDUA, FORM FACTORS, AND COMPOSITE PARTICLES. Arnold, R. C.; Fenster, S. (Argonne National Lab., Ill.).

The significance of a relation such as the Van Hove formula

$$d\sigma/dt \sim [G_{s_{cm}}(t)]^4$$

generalized to hadrons is explored in the context of the analysis of singularities in the angular momentum plane of high-energy scattering amplitudes. In particular it is supposed that a Pomeranchuk Regge pole with $a(0) = 1$ is responsible for the high-energy asymptotic behavior at small $|t|$ of elastic scattering amplitudes. The properties of the residua of other Regge poles are considered in a model in which corrections to the Van Hove formula and the question of whether all corrections die out for large enough energy are also discussed. It is also shown in this model that relations such as the Van Hove relation hold even if there are singularities near $\alpha = 1$ other than poles which dominate the asymptotic quark–quark scattering behavior. (J.F.P.)

39299 (IPNO/TH-123) SCHWINGER'S ANGULAR MOMENTUM CALCULUS AND THE DIRAC BRACKET. Gyoergyi, G. (Paris Univ., Orsay (France). Institut de Physique Nucleaire); Koevesi-Domokos, S. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar. 1968. 15p. Dep.

It is shown that the Schwinger angular momentum calculus can be obtained from the conventional three-dimensional rigid rotator (inertial motion of a mass point on a sphere). An essential tool to achieve this is the concept of the Dirac bracket. The quantization procedure proposed by Dirac for systems subject to constraints is adopted. The de Sitter dynamical group SO(3,2) serves as a framework of the treatment. (J.F.P.)

39300 (JINR-P2-3827) σ-MODEL AND EQUAL TIME CURRENT-CURRENT COMMUTATORS IN THE PERTURBATION

THEORY. Usyukina, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. (In Russian). Dep.

Simultaneous commutation relations of vector and axial vector currents are investigated for σ-model in the framework of the perturbation theory. The operator and isotopic structure of non-canonical members in the current commutators for equal times is considered. (auth)

39301 (JINR-P2-3865) RELATIVISTIC TWO-BODY PROBLEM WITH SEPARABLE INTERACTION. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

The relativistic two-body problem with separable interaction was considered. An exact solution of the problem for the factorizing kernel of the Bethe-Salpeter equation was obtained. The conditions were formulated, under which the Bethe-Salpeter equation and the corresponding quasipotential equation determine one and the same spectrum of the a stationary states of two particles. (auth)

39302 (NYO-2262-TA-184) THEORETICAL HIGH-ENERGY PHYSICS. Progress Report for a Research Program. Feldman, David (Brown Univ., Providence, R. I. Dept. of Physics). June 1, 1968. Contract AT(30-1)-2262. 9p. Dep. CFSTI.

A summary is presented of research on theoretical physics during the year September 1967, to August 31, 1968. The present status of the theoretical group, brief summaries of papers published and to be published, and the scientific personnel are considered. (J.F.P.)

39303 MULTIPLE SCATTERING OF LIMITED BEAM ON PLANE LAYER. Gnedin, Yu. N.; Dolginov, A. Z.; Silantev, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 7: 984-91(May 1968). (In Russian).

Multiple scattering of a beam of particles (neutrons, photons) with a limited cross section on a plane thick target is considered. The distribution of particles inside the body is determined. (auth)

39304 BOUND STATES OF THREE IDENTICAL BOSONS. Humberston, J. W. (University Coll., London); Hall, R. L.; Osborn, T. A. Phys. Lett., 27B: 195-8(July 8, 1968).

Results are given of three methods for calculating bound state solutions of the three-body problem. For J = 0 states a variational method is used to give rigorous upper bounds on the bound state energies, and a rigorous lower bound on the ground state energy is also obtained. Finally, Faddeev's equations are solved keeping only the S-wave in the two-body partial wave expansion. Also, the ability of separable interactions to reproduce our results is tested. (auth)

39305 UPPER LIMIT OF THE ELEMENTARY PARTICLE RADIUS. Nguyen-van-Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 1111-13(May 1968). (In Russian).

Some upper bounds on the rms radius of elementary particles are obtained depending on the behavior of the form factor modulus on the cut. (auth)

39306 CLASSICAL RELATIVISTIC ANGULAR MOMENTUM FOR INTERACTING POINT PARTICLES. Schmieg, Glenn Melwood. Chapel Hill, N. C., Univ. of North Carolina, 1967. 103p. Thesis.

Theories of direct action and fields can play complementary roles in the description of interacting particles. In the case of direct action, a wide variety of forces and equations of motion are possible, all within a relativistic framework. For the special case of inverse square forces, there is an asymptotic interaction angular momentum. When this is computed for Rutherford scattering and combined with the particle angular momentum, the resulting total angular momentum has the correct tensor properties. The interaction angular momentum is formulated in adjunct field theory. The methods used by Wheeler and Feynman for linear momentum are found to be unsatisfactory for angular momentum. Two modifications are given to correct this difficulty; in the first, an absorber is used, and in the second, field quantities are given by integrals over finite regions rather than the customary all space. The magnitude of the asymptotic angular momentum is computed for several experimental situations. The numerical values involved are found to be quite small. (Disser. Abstr.)

39307 QUANTUM FLUCTUATION OF GRAVITATIONAL FIELD AND CREATION OF MATTER. Hokkyo, Noboru (Hitachi Central Research Lab., Kawasaki, Japan). Prog. Theor. Phys. (Kyoto), 39: 1078-9(1968).

The upper limit of the total mass-energy contained in the volume ^{3}L, where L is classical electron radius, is estimated from the maximum curvature of space associated with the quantum fluctuation of the gravitational field (metric). It is found that this mass-energy is of the order of magnitude of that of the universe. It is therefore suggested that the Hubble universe emerged out of a spatial region of linear dimensional L, and that this dimension determined the level spacing of the mass spectrum of elementary particles. (J.F.P.)

39308 BRIEF SURVEY OF RECENT ALGEBRAIC APPROACHES TO PARTICLE PHYSICS. O'Raifeartaigh, Lochlainn (Inst. for Advanced Study, Princeton, N. J.). pp 49-85 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

A brief summary of the major purely algebraic developments in particle physics in the last four or five years is given. It is suggested that there was a general trend in these developments toward infinite-component wave equations. The infinite-component wave theories are described in particular, their structure, uses, and problems. (J.F.P.)

39309 INTRODUCTION TO CURRENT ALGEBRA. Nauenberg, Michael (Univ. of California, Santa Cruz). pp 327-82 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968. See CONF-670728.

The Adler-Weisberger relation is discussed, and other applications are selected to illustrate the scope of current algebra and some of its problems and limitations. Current, charges, and equal-time commutators, form factors and current conservation, parity, charge conjugation, and time reversal, pole dominance of the divergence of the axial vector current, and renormalization of the axial vector coupling constant: the Adler-Weisberger relation and the pion-nucleon scattering lengths are treated. Also semileptonic K decays, dispersion relation techniques for the gradient of the δ function in the equal-time current-current commutators, and tests of equal-time current-current commutation relations are discussed. (J.F.P.)

39310 PROGRESS IN FIVE CORAL GABLES CONFERENCES ON SYMMETRY PRINCIPLES AT HIGH ENERGY. Ne'eman, Yuval (Tel-Aviv Univ., Israel). pp 355-73 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

A five-year summary of Coral Gable conferences is presented. The summary briefly mentions the very high-energy particle interactions, search for quarks, strange hadrons, decays, the Poincaré group, CP violation, various space-time symmetries, Regge poles, SU(3) symmetry, scattering, symmetry breaking, field theory, superconvergence, sum rules, and current algebra. (auth)

39311 CHAIRMAN'S INTRODUCTION: SOME REMARKS ON TIME REVERSAL. Teller, Edward (Univ. of California, Livermore). pp 1-6 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

The question of whether the violation of time reversibility in elementary particle processes, that is, of T invariance, may invalidate the second law of thermodynamics is considered and its errors discussed. It is suggested that the conservation in phase space should be proven using matrices that correspond to infinitesimal increments in time. This seems to be sufficient in order to lay the foundations for the second law. (J.F.P.)

39312 γ-INVARIANT COVARIANTS FOR ANY SPIN. Sankaranarayanan, A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim., 56A: 459-66(July 21, 1968).

It is shown that the number of bilinear covariants (generalized currents) for spin s in the 2(2s + 1)-component formalism is (2s + 4) and of all these only two bilinear covariants survive when one imposes the γ_5-invariance condition irrespective of the value of spin. It also follows that the current four-vector is also invariant under this γ_5-transformation for arbitrary spin. (auth)

39313 DEFINITION OF CREATION AND ANNIHILATION OPERATORS OF COVARIANT UNSTABLE PARTICLE. Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 343-8(1968).

A local, scalar, covariant generalized free field satisfying certain four-dimensional commutation relations is considered. It is assumed that the delta function is not present and that the continuous part is described by a function $\sigma(\kappa)$ of rapid decrease and vanishing for all $\kappa^1 \leq \mu^1$, where $\mu^1 \geq 0$. The normalized mass

spectrum is also considered. The main purpose is to find a one-to-one correspondence between the one-time vacuum expectation values of some operators, which play the role of the creation and annihilation operators, and the choice of the generalized free field. To illustrate the method the formulation of the theory of the usual free scalar field and the generalization of this approach to the case of the continuous mass spectrum are presented. It is shown that the three-dimensional integration is sufficient in the procedure of unique determination of a covariant unstable particle. A preliminary result is given which is necessary for the generalization of the Haag–Ruelle theory of asymptotic fields. (J.F.P.)

Electromagnetic

Refer also to abstracts 39348, 39352, 39384, 39429, 39480, and 39493.

39314 (CERN–68-7(Vol.1), pp 431-40) ELECTROMAGNETIC CORRECTIONS TO THE DISPERSION RELATIONS FOR HIGH ENERGY FORWARD SCATTERING. Soloviev, L. D. (European Organization for Nuclear Research, Geneva (Switzerland)).

In order to test causality on the level of the strong and electromagnetic interactions two possible ways of analyzing the role of the ordinary electromagnetic interaction of hadrons in the dispersion relations for their scattering are considered. The first is to calculate the electromagnetic corrections to the nuclear amplitude and test the well-known dispersion relations for nuclear interactions. Secondly, one can try to analyze general properties of the scattering amplitude which is derived directly from experiment and contains the contributions of both strong and electromagnetic interactions, and to derive dispersion relations for this amplitude. (J.F.P.)

39315 (INR-P-908/XVIII/PP) KLASYCZNE PODEJSCIE DO PROBLEMU KWANTOWANIA I ZJAWISK FALOWYCH. (Classical Approach to Quantum and Wave Phenomena). Gryzinski, Michal (Institute of Nuclear Research, Warsaw (Poland)). 1968. 5p. (In Polish). Dep.

It is shown that the inherent dependence between the translational motion of the electron and the motion of its spin axis—which results in appearance of the alternating component of the electric field—is the cause of "wave" phenomena and quantization of energy. (auth)

39316 (JINR–E2-3853) ELECTROMAGNETIC MASS DIFFERENCE OF KAONS. Struminskii, B. V.; Zinovjev, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 7p. Dep.

The electromagnetic K-meson mass difference was calculated on the basis of the finite energy sum rules for the virtual Compton-effect amplitude. (auth)

39317 (JINR–P2-3845) FOTOROZHDENIE MEZONOV POLYARIZOVANNYMI FOTONAMI I EFFEKT PRIMAKOVA. (Meson Photoproduction by Polarized Gamma Rays and the Primakoff Effect). Lapidus, L. I.; Musakhanov, M. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 6p. (In Russian). Dep.

It is shown that experiments on the Primakoff effect on a spinless nucleus with polarized photons, give better possibilities to select contributions of coherent and noncoherent processes with an excited nucleus which has a nonzero spin value in final states. This gives new possibilities to make improvements in measurement of the η-meson lifetime. (auth)

39318 ON POLARIZATION OF FINITE PARTICLES IN PROCESSES $e^+e^- \to 2\gamma$ AND $e^+e^- \to \mu^+\mu^-$ AT HIGH ENERGIES. Zeldovich, B. Ya.; Terentev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 1083-93(May 1968). (In Russian).

Spin correlations in the mentioned processes in colliding electron-positron beams are calculated in framework of the conventional quantum electrodynamics. The longitudinal circular polarization of the finite particle survives at high energies. This polarization is related to the T-odd correlation due to the radiation corrections and has the order of magnitude of 0.1α for $e^+e^- \to 2\gamma$ and of 3α for $e^+e^- \to \mu^+\mu^-$. An experimental detection of the polarization is of interest for a test of the lepton quantum electrodynamics. The C-invariance section rules for processes in colliding e^+e^- beams are discussed. (auth)

39319 ASYMPTOTIC BEHAVIOUR OF FORM FACTORS OF HALF-INTEGER SPIN PARTICLES. Caneschi, L. (Scuola Normale Superiore, Pisa, Italy). Nuovo Cim., 56A: 551-2 (July 21, 1968).

The composite model of hadrons is used to obtain bounds on the asymptotic behavior of form factors of half-integer spin particles. In particular, the N^* electroproduction and the N^* form factors are considered. (L.B.S.)

39320 POLARIZATION EFFECTS IN REACTIONS WITH ULTRARELATIVISTIC ELECTRONS. Khoze, V. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz., 7: 1094-9(May 1968). (In Russian).

A number of effects appearing in the annihilation of arbitrary polarized electrons and positrons are considered, and some results regarding the scattering of fast electrons on protons and pions are obtained using interaction invariance relative to rotations and reflections as well as the conservation of helicity of ultrarelativistic electrons. (auth)

39321 PI-PAIR PRODUCTION WITH POLARIZED X-RAYS. Morrison, R. W. (Stanford Univ., Calif.); Drickey, D. J.; Mozley, R. F. Nuovo Cim., 56A: 409-16(July 21, 1968).

A study was made of the reaction $\gamma + p \to \pi^- + N^{*++}(1238)$ using a polarized X-ray beam. The essentially null result obtained for the production asymmetry can assist in determining the OPE contribution to this reaction. (auth)

39322 LIGHT SCATTERING BY AN ELECTRON MOVING IN A REFRACTING MEDIUM. Frank, I. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 1100-5(May 1968). (In Russian).

The scattering of light by a charged particle moving in the refracting medium is considered. It is shown that besides the ordinary scattering when the incident photon transforms into the scattered photon, there is another mechanism when the initial photon is not absorbed but induces another photon and, furthermore, a scattered light photon emerges. Relations are obtained which connect the frequency of the primary light with that of the scattered light for both these cases, i.e., for normal and for anomalous scattering. The condition for frequencies of the Vavilov–Cherenkov two-photonic effect is presented. (auth)

39323 GENERAL RELATIONS BETWEEN PHOTOPRODUCTION OF PIONS AND VECTOR MESON PRODUCTION BY πN COLLISION BASED ON THE PHOTON–VECTOR-MESON ANALOGY MODEL. Iso, Chikashi; Yoshii, Hiroaki (Tokyo Inst. of Tech.). Ann. Phys., (N. Y.) 47: 424-38(May 1968).

The relations among differential cross section, polarization and helicity density matrix elements in $\gamma N \to \pi N$ and $\pi N \to VN$ processes are given for the photon–vector-meson analogy model. For example, the differential cross sections of $\gamma N \to \pi N$ processes are given in terms of density matrix elements and differential cross sections of $\pi N \to \rho N$ processes, and the relations fit the experimental data fairly well. (auth)

39324 HIGH-ENERGY HADRON ELECTROMAGNETIC SCATTERING. Rekalo, M. P. Yadern. Fiz., 7: 1106-10 (May 1968). (In Russian).

High-energy hadron scattering cross sections due to the strong and electromagnetic interactions are compared. Hadron interaction cross sections quickly decrease with the energy of colliding particles at fixed values of the momentum transfer; as for the cross section due to the electromagnetic interactions (one γ-quantum exchange in t channel), at fixed value of t and at high energies, it tends to a constant value. Therefore, the energy must appear starting with which the electromagnetic interaction becomes "stronger" than the strong one. For πp scattering this phenomenon must be observed starting from 30-GeV π-meson energy, in the case of pp scattering, higher energies are required. (auth)

39325 SUPER CONVERGENT SUM RULE FOR PION PHOTOPRODUCTION ON Λ^0. Srivastava, Prem P. (International Centre for Theoretical Physics, Trieste, Italy). An. Acad. Brasil. Cienc., 39: 386-91(Dec. 31, 1967).

For the study of a superconvergent sum rule in the photoproduction of pions on Λ^0 it is assumed from Regge pole theory that the high-energy behavior of each amplitude is determined by the leading Regge trajectory which can be exchanged in the t-channel. The crossing symmetry relation implies that one must only consider the direct uncrossed graphs in the s-channel $\gamma + \Lambda \to \Lambda + \pi^0$. It is concluded that the sum rule obtained above is very well satisfied within the framework of SU(3) symmetry and the transition magnetic moment for $\Sigma^0(1385) \to \Lambda^0 + \gamma$ turns out to be $-\frac{2}{3}\sqrt{2}\,\mu p(1.15)$. (J.F.P.)

39326 RADIATIVE CORRECTIONS TO THE RESONANT PARTICLE PRODUCTION. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 27B: 223-5(July 8, 1968).

Radiative corrections to the resonant cross sections of particle production in colliding beam experiments have been calculated. (auth)

39327 SOFT-PHOTON EMISSION APPROACH TO $\Gamma(\eta \rightarrow 2\gamma)/\Gamma(\pi^0 \rightarrow 2\gamma)$ WITH SU(3)-SYMMETRY BREAKING. Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan). Nucl. Phys., B6: 155-8(1968).

Using the technique of soft-photon emission and the partial conservation of the tensor currents, the branching ratio $\Gamma(\eta \rightarrow 2\gamma)/\Gamma(\pi^0 \rightarrow 2\gamma)$ was calculated including the first-order SU(3)-symmetry breaking of the decay constants, and found to be consistent with the recent measurements. (auth)

39328 BARYON ELECTROMAGNETIC TRANSITIONS IN THE THREE-TRIPLET MODEL. Karl, G.; Obryk, E. (Dept. of Theoretical Physics, Oxford). Nucl. Phys., B6: 102-6(1968).

Matrix elements for M1 transitions between the proton and baryonic resonances are computed in the three-triplet model. Selection rules for electromagnetic transitions are discussed. The prediction of zero matrix element for the M1 transition to the $P_{11}(1470)$ is compared with experimental data. (auth)

39329 POLARIZATION DEPENDENCE OF ELASTIC LEPTON (ANTILEPTON NUCLEON ELECTROMAGNETIC SCATTERING). Kerimov, B. K.; Takwale, R. G. (Moscow State Univ.). Indian J. Pure Appl. Phys., 6: 58-61(Feb. 1968).

A general expression for the differential cross-section of elastic scattering of leptons (electrons and μ-mesons) and antileptons (positrons and μ^+-mesons) on a proton target was obtained by taking into account spin vectors of the particles in the initial and final states and also the mass of the lepton and antilepton. The cross section obtained in the laboratory system was expressed in terms of charge and magnetic form factors. The formula is used to investigate angular distribution of the degree of polarization. In case of scattering of unpolarized leptons by a polarized proton target, scattered leptons get polarized, degree of transverse polarization being proportional to the mass of lepton. In the scattering of a longitudinally polarized beam by an unpolarized proton target, the recoil protons, which are scattered in the direction of incident leptons, are completely longitudinally polarized. (auth)

39330 CURRENT COMMUTATORS AND MASS EXTRAPOLATIONS THEORY AND APPLICATIONS. Nicodemi, Francesco. Syracuse, N. Y., Syracuse Univ., 1967. 159p.

Thesis.

"Soft pion" processes are discussed. The relations of an algebra of vector and axial vector currents for the strongly interacting particles are used together with off-mass-shell extrapolations of the scattering amplitudes to obtain information on the low energy behavior of several reactions involving pseudoscalar mesons. The equal time commutation relations between two axial vector currents lead to the derivation of the S- and P-wave scattering lengths and S-wave effective ranges of some of the meson-baryon and meson-meson elastic scattering amplitudes. Similarly the knowledge of the commutator of a vector and an axial vector current allows the determination of the low energy parameters for the S- and P-wave multipole amplitudes for the process $\gamma + N \rightarrow N + \pi$ where γ is an isoscalar photon. The results are found to be in reasonably good agreement with the experimental data whenever the latter are available. The technique for obtaining these numbers consist in defining an off-mass-shell extrapolation for the scattering amplitude, which simplifies considerably at zero "pion mass." The physical amplitude is then approximated in terms of the value of this extrapolation and of a few of its derivatives at the unphysical point. The mathematical foundations of this technique are analyzed in some detail and the ambiguities inherent in any off-mass-shell approach to physical phenomena are emphasized. In particular it is pointed out that the extrapolation normally used for processes involving photons does not satisfy the current conservation constraint when the photon is an isovector. (Disser. Abstr.)

39331 NEUTRINO PAIR RADIATION BY RELATIVISTIC ELECTRON BREMSSTRAHLUNG. Festa, George G. New York, New York Univ., 1967. 128p.

Thesis.

Starting with the assumption that there exists a direct coupling between the electron and neutrino, the neutrino pair flux produced when hot, degenerate, relativistic electrons undergo scattering with positively charged nuclei by a shielded Coulomb interaction is calculated. This process is called neutrino bremsstrahlung. Several models of white dwarfs and neutron stars are calculated, and it is shown that their electrons exist in a hot, degenerate, relativistic state. The neutrino pair flux calculation is then applied to white dwarfs and neutron stars and compared with other forms of energy radiation from these stars. It is found that there exist temperature regimes in which the neutrino bremsstrahlung calculation gives larger luminosities than either optical photon radiation or other neutrino pair-producing mechanisms. Next the effect on the neutrino flux if the positive nuclei were to form a lattice instead of being randomly oriented is examined. Such a lattice state is shown theoretically to exist for some regimes of temperature and density in white dwarfs. It is found that for temperatures much below the Debye temperature coherent scattering, i.e., scattering off a rigid lattice, reduces the neutrino flux from that calculated with randomly oriented nuclei by about two orders of magnitude. For temperatures much higher than the Debye temperature, a more important region physically, the neutrino flux is the same as that calculated for randomly oriented nuclei. (Disser. Abstr.)

39332 INVESTIGATION OF THE EQUAL TIME COMMUTATORS OF CURRENT OPERATORS IN RENORMALIZED PERTURBATION THEORY. Langerholc, John Mark. Pittsburgh, Univ. of Pittsburgh, 1967. 43p.

Thesis.

Equal time commutators of finite, renormalized current densities are considered in the first two orders of perturbation theory for the models of photon–nucleon and meson–nucleon interaction. After giving a definition of "equal times" for distributions, the commutators of vector currents in electrodynamics are calculated without the use of a cutoff for the cases where a higher symmetry exists, and where it is broken. Extra terms are found for the commutator or zeroth components as well as the "Schwinger terms." Divergences are obtained in this model for the commutator of two identical spacelike components and for the zeroth components in the Johnson–Low model. Discrepancies arising from the use of a cutoff during the calculation are discussed, and the properties of the extra terms are examined. (Disser. Abstr.)

39333 COVARIANT THEORY OF THE DISINTEGRATION OF THE DEUTERON BY PHOTONS AND PIONS AT HIGH ENERGY. George, David John. Stanford, Calif., Stanford Univ., 1967. 109p.

Thesis.

The disintegration of the deuteron was investigated in the region of the first nucleon resonance, using the model suggested by Austern (Phys. Rev. 100: 1522(1955)). The main impetus for the work was the new set of measurements of the asymmetry found in photodisintegration by Liu (Phys. Letters 11: 306(1964); Phys. Rev. 138: B1443(1965)), which were of opposite sign to that predicted by conventional theory. It was also desired to see whether the model could explain the proton polarization in photodisintegration and pion disintegration. The method used was that of relativistic perturbation theory. It was also indicated how the method could be used to calculate electrodisintegration of the deuteron. (TSS) (Disser. Abstr.)

39334 ANGULAR DISTRIBUTION OF THE BREMSSTRAHLUNG OF HIGH-ENERGY ELECTRONS ON DIAMOND CRYSTALS. Avakyan, R. O.; Armaganyan, A. A.; Darbinyan, S. M.; Sekhposyan, E. V. (Inst. of Physics, Erevan). Dokl. Akad. Nauk Arm. SSR, 45: No. 1, 3-7(1967). (In Russian).

The angular distribution of the bremsstrahlung produced by high-energy electrons scattered by diamond crystals was investigated; since the energy of the emitted photons depends on the scattering angle of the electrons, the effect could have application in the study of the photoproduction of elementary particles. The energy spread was limited by selecting a narrow range of radiation. Calculations were made to predict the angular distribution of the 1-GeV photons produced by 6-GeV electrons. An electron scattering angle $\theta = 1.55$ milliradians was chosen with respect to the [110] crystal axis; the angle a between the [110] and [110], [001] planes was assumed to be zero. The theory predicted several sharp lines in the angular distribution. It was shown that a proper combination of the angles θ and α allows one to collimate a specific line. Detailed calculations were carried out for the following cases: 3-GeV photons, 6-GeV electrons, $\theta = 50$ milliradians, $\alpha = 2.5°$; 4-GeV photons, 6-GeV electrons, $\theta = 50$ milliradians, and $\alpha = 5.0°$. (TTT)

39335 ONE-PHOTON AND TWO-PHOTON PHOTO-PION PRODUCTION. Prakash, Hari; Vachaspati (Univ. of Allahabad, India). Indian J. Pure Appl. Phys., 6: 155-60(Apr. 1968).

The phenomena of one-photon and two-photon positive, negative and neutral photo-pion productions were studied in the perturbation theory, treating the nucleons and pions as the nonrelativistic Schrödinger and scalar Klein–Gordon particles respectively. The variation of the cross sections of these processes is discussed. When the initial nucleon is taken to be at rest it is found that the cross sections of the one-photon charged photo-pion production and two-photon charged and neutral photo-pion productions are zero before and at some threshold values of the photon energy On increasing the photon energy, they increase from zero to maximum values and then tend to zero asymptotically. The cross section of one-photon photo-pion, however, increases from zero

at the threshold value tending asymptotically to be a nonzero value. (auth)

39336 LORENTZ INVARIANCE IN REGGEIZATION OF PION PHOTOPRODUCTION AMPLITUDES. Ebata, T.; Lassila, K. E. (Ames Lab., Iowa). Phys. Rev. Lett., 21: 250-4(July 22, 1968). (IS-1827).

The implications of Lorentz and gauge invariance for Reggeization of the pion trajectory in charged pion photoproduction are studied and it is found that the pion pole need not be introduced as a kinematical singularity. As a consequence of having a dynamical Regge pion pole, it is found that effects characteristic of an s-channel nucleon pole appear automatically. (auth)

39337 GAUGE INVARIANCE WITH NON ZERO PHOTON BARE MASS. Jouvet, Bernard (College de France, Paris). pp 257-72 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.
See CONF-670728.

The previously given proofs are reviewed for the statements that the self-energy of the photon $\delta\mu^2$ can be expressed by a Lehmann relation $\delta\mu^2 \sim \int\rho$ (a)ada which ensures that it is different from zero (in agreement with perturbation theory) and allows it to be related to the observable asymptotic behavior of the propagator, and that even though $\delta\mu^2 \neq 0$ the theory is still gauge invariant and in particular there exists a Ward theorem implying that δ/δ (ieA$_\mu$) $\sim \delta/\delta$ k$_\mu$ (electron), where A$_\mu$ is a constant and uniform external potential, then it follows that there is a relation, at least formal, between the function $\rho(a,\alpha)$ and its derivative $\delta\rho(a,\alpha)/\delta\alpha$; this relation leads to an iterative method of calculation of the asymptotic behavior of $\rho(a,\alpha)$. Also some of the consequences of the first statement are discussed. (J.F.P.)

39338 MODEL OF CP VIOLATION. Nishijima, K. (Tokyo Univ.). pp 175-210 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.
From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

A new model of nonleptonic decays is proposed based on an assumption that both CP-conserving and -violating decays can be attributed to the same primary interaction. The lack of observation of large CP-violating effects corresponding to the first-order interaction f $\sim 10^{-3}$, and the possible form of this interaction are considered. The primary interaction, the selection rule $|\Delta S| < 2$ and a new set of constraints, the content of the constraints, determination of the coupling constant f, the selection rule $|\Delta S| < 2$ in the third order, the CP-violating decays, and the electric dipole moment of the neutron are covered. (J.F.P.)

39339 CHARGE QUANTIZATION AND NON-INTEGRABLE LIE ALGEBRAS. Hurst, C. A. (Univ. of Adelaide. Univ. of Miami, Coral Gables, Fla.). pp 105-13 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.
From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

Generalization of the Schwinger field theory of magnetic charge is considered. It is found that one can construct numerous examples of Hamiltonians with quantized charges which mimic the example of the magnetic charge. For example, for the group SU(2) (as opposed to 0(3)) one could construct a Hamiltonian which has an oscillator spectrum but does not have SU(2) symmetry unless the interaction constant is quantized. Also in these situations it is likely that the spectrum of the Hamiltonian does not have the correct multiplet structure unless the charge is quantized, for symmetry under a Lie algebra is not sufficient to ensure this. (J.F.P.)

39340 SUM RULES FOR THE MIXING ANGLES OF THE BARYONS IN SU(3) x SU(3) CHIRAL ALGEBRA AT INFINITE MOMENTUM. Buccella, F. (Univ., Florence); de Maria, M.; Lusignoli, M. Nucl. Phys., B6: 430-40(1968).

Under the assumption that axial charges couple the baryon octet only to one-particle states belonging to 1,8,10 SU(3) representations, sum rules for the mixing angles of the baryon wave function are derived. The results obtained from their saturation are in good agreement with the known electromagnetic properties of nucleons. (auth)

39341 ANALYTICITY PROPERTIES OF TWO-BODY HELICITY AMPLITUDES FOR REACTIONS INVOLVING MASSLESS PARTICLES. Ader, J. P. (Laboratoire de Physique Theorique, Bordeaux); Capdeville, M.; Navelet, H. Nuovo Cim., 56A: 315-81(July 21, 1968).

Taking into account gauge conditions, helicity amplitudes for processes involving massless particles are expressed via the spinor amplitudes in terms of the Joos invariant amplitudes which have been shown to be free from kinematical singularities if at least one particle is massive. The procedure allows the kinematical singularities of helicity amplitudes to be analyzed and separated out, which results in the definition of regularized helicity amplitudes. A crossing matrix for helicity amplitudes is written down, which corresponds to a well-defined crossing path for spinor amplitudes. Such a path is assumed to exist when massless particles are involved. It is shown that this matrix can be obtained from the matrix for the massive case by putting some masses equal to zero. Kinematical constraints which generalize to the case of arbitrary spin relations which must hold between helicity amplitudes at some values of the energy variable in $\gamma\pi \to N\bar{N}$, $\gamma K \to \Lambda\bar{N}$ reactions, appear as a consequence of the existence of poles in the crossing matrix between regularized helicity amplitudes. (auth)

39342 APPROXIMATION FOR ANGULAR AND ENERGY DEPENDENCE OF THE π^+-PHOTOPRODUCTION CROSS SECTIONS ON PROTONS IN THE NEAR-THRESHOLD ENERGY REGION. Adamovich, M. I.; Larionova, V. G.; Latypova, R. A.; Kharlamov, S. P.; Yagudina, F. R. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 1069-82(May 1968). (In Russian).

Shape of the energy dependence of the π^+-meson photoproduction differential cross section is determined under twelve fixed angles θ in cms in the energy interval from the threshold up to 200 MeV. The threshold value of the electric dipole amplitude squared is obtained to be $E_{0+}^2 = (16.3 \pm 0.18) \cdot 10^{-30}$ cm^2. Analysis of the angular distributions indicates a considerable influence of the direct photon interaction with the pion current on the shape of the angular distributions in the energy region up to 230 MeV. Extrapolating the angular distributions to the one pion pole cos $\theta = 1/\beta$ the pion-nucleon coupling constant is obtained $f^2 = 0.07 \pm 0.01$. (auth)

Weak

Refer also to abstract 39387.

39343 (UCRL-18231) COMMENTS ON THE DISCREPANCIES IN THE MEASUREMENTS OF ξ IN $K^+ \to \pi^0 + \mu^+ + \nu$. Stiening, R. F. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 12p. (CONF-680439-2). Dep. CFSTI.
From Meeting of the American Physical Society, Washington, D. C.

The nature of the disagreement between the various experimental determinations of ξ in $K^+ \to \pi^0 + \mu^+ + \nu$ decay is illustrated, and several explanations previously suggested for resolving it are discussed. Experimental references are confined to work on K^+ decay, although K^0 decay data also generally support the conclusions drawn. It is found that the reported discrepancies in determinations of ξ must be attributed either to incorrect experimental data or to a violation of muon-electron weak universality. (J.F.P.)

39344 CP SNOW. Fitch, Val L. (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 2: 63-7(May-June 1968).

A discussion is given on the nature of the observations made by Yang and Wu (Phys. Rev. Letters; 13: 180(1964)), which have been used for analyzing the phenomenology of the 2π decays of the K^0. The extent to which the present experimental data fit the Wu-Yang picture is discussed. (L.B.S.)

39345 RATIO BETWEEN THE AMPLITUDES OF $K^+ \to \pi^+\pi^0$ AND $K_1^0 \to \pi^+\pi^-$ DECAYS. Kobzarev, I. Yu. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 1150-1(May 1968). (In Russian).

Previously it was shown that the decay $K^+ \to \pi^+\pi^0$ forbidden by the rule $\Delta T = 1/2$ takes place at the expense of the mass difference of π^+ and π^0 mesons mass. Using the PCAC hypothesis and SU(3) symmetry Y. Hara et al., (Phys. Rev. Lett. 16, 875(1966)) obtained the ratio between M amplitudes: $R = M(K^+ \to \pi^+\pi^0)/M(K_1^0 \to \pi^+\pi^-) = m_{\pi^+}^2 - m_{\pi^0}^2/2m^2 \approx 1/370$. This ratio holds for the case in which the decay $K_1^0 \to \pi^+\pi^-$, forbidden by SU(3) symmetry, takes place at the expense of the k and π mass difference. An attempt was made to show that using the same assumptions the above ratio may be obtained with the PCAC hypothesis. (R.V.J.)

39346 RADIATIVE CORRECTIONS TO BETA DECAY AND SOME SUM RULES FOR NEUTRINO INTERACTIONS. Quinn, Helen Rhoda. Stanford, Calif., Stanford Univ., 1967. 102p.
Thesis.

Two separate weak interaction calculations are performed. The first is a calculation of the electromagnetic radiative corrections to spin averaged forward nonspin-flip beta decay for a state of any spin and isospin. The effects of strong interactions are included by current algebra techniques and complete gauge independence is maintained. The correction is found to

contain a logarithmically divergent term. The coefficient of this term is model dependent. In models where the fundamental fields which carry the current are spin ½ objects and consist only of isotopic singlets, and isotopic doublets all having the same average charge $\overline{Q}$, the coefficient is independent of the construction of the decaying state. It vanishes in the V−A theory for $\overline{Q} = -½$. For a more complicated isotopic structure for the fundamental fields the coefficient of the divergent term may depend on the structure of the decaying state and so vary for different states. Because of other divergences in the weak interaction theory, this result is not thought to be a very strong reason for choosing $\overline{Q} = ½$ models for the fundamental fields. Using the unitarity cutoff of 300 MeV and the Gell-Mann and Zweig quark model this calculation gives $\cos\theta_c = 0.968 \pm .002$ from O_{14} β-decay. A cutoff in the range 10−30 BeV gives good agreement with the value of $\cos\theta$ obtained from K-decay. The second calculation applies three sum rules for neutrino nucleon interactions to underground neutrino experiments. A lower bound on the counting rate is estimated and comparision with experimental rates shows that fairly high inelasticities are required to saturate the sum rule. The effect of a W-boson on the muon spectra for such experiments is also as estimated using the sum rules. It appears that, if the various assumptions made in this treatment are correct, it will be difficult to improve on the present lower bound for the mass of the W-boson by this method. Finally some sum rules for simple potential models are discussed to try to gain some understanding of the way in which such relations are saturated. (Disser. Abstr.)

39347 THE CP PUZZLE: STRANGE DECAYS OF THE NEUTRAL KAON. Kabir, P. K. London, Academic Press, 1968. 137p. 40s.

The discovery of $K_1^0 \to 2\pi$ decay modes led to the conclusion that the laws of Nature are unsymmetric as between particles and antiparticles, and that an absolute distinction can be made between left and right. A concise and self-contained account is given of this revolutionary discovery and of its theoretical interpretation under the following chapter headings: The neutral kaon; $K_1^0 \to 2\pi$ decay; $K_2^0 \to 2\pi$ decay and the origin of CP-noninvariance; regeneration and the $K_2^0 - K_2^0$ mass difference; interference phenomena in K^0-decays; the meaning of CP-nonvariance. Appendixes include: The decay formalism; parameters of the neutral kaon complex; consequences of TCP and T invariance; phenomenological analysis of $K_2^0 \to 2\pi$ decay. (U.K.)

39348 FINITE-WIDTH CORRECTIONS TO THE VECTOR-MESON-DOMINANCE PREDICTION FOR $\rho \to e^+e^-$. Gounaris, G. J.; Sakurai, J. J. (Univ. of Chicago). Phys. Rev. Lett., 21: 244-7(July 22, 1968).

Finite-width corrections based on a generalized effective range formula for pion-pion scattering modify by a non-negligible amount the well-known relation between $\Gamma(\rho \to e^+e^-)$ and $\Gamma(\rho \to \pi\pi)$ derived on the basis of vector-meson dominance. A new current-algebra prediction is also presented for the shape and magnitude of $\sigma(e^+e^- \to \pi^+\pi^-)$ and the ρ-meson contribution to the Schwinger term is estimated. (auth)

39349 BIBLIOGRAPHY OF THE NEUTRINO. Kuchowicz, B. New York, Gordon and Breach, Science Publishers, 1967. 445p. $13.50.

The bibliography contains all papers related to the neutrino problem which were published before autumn 1965. The papers are arranged chronologically by year, and within a year they are ordered alphabetically according to the name of the first author. Titles of the papers are given in the original language with the English translation usually given in parentheses, an exception being languages using other alphabets as Cyrillic in which only the English translation is given. Subject, author, conference, language, and book, report, and dissertation indices are given. (J.F.P.)

39350 RADIATIVE CORRECTIONS TO β-DECAY INCLUDING STRONG INTERACTION EFFECTS. Jaus, W. (Univ., Zurich). Nucl. Phys., B6: 408-20(1968).

Using the conservation of isovector-vector current, relations are derived between the electromagnetic form factors and the amplitude of β-decay accompanied by one or two γ-quanta emission. Assuming the ρ-meson dominance hypothesis, this then enables radiative corrections to the β-decay of the π-meson to be calculated. Using the experimental form factors of the nucleon, the same procedure (which by construction is gauge invariant) is applied to obtain the electromagnetic corrections to a pure Fermi transition. The point of view is adopted that the divergent contribution of the axial weak current cancels the logarithmic divergence due to the isovector-vector current. The numerical results are larger by about 0.4% than those given previously. (auth)

39351 THE β-DECAY OF Ω^--HYPERON. Ershov, D. K. (Smolensk State Teachers Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 22-6(1968). (In Russian).

Beta-decay of Ω^- hyperon ($\Omega^- \to Y^0 + l^- + \bar{\nu}$) were studied taking into account polarization of produced particles. Decay probabilities, energy spectra, the degree of longitudinal polarization, and the generated electron and hyperon spin correlation coefficient are calculated. The coefficient and longitudinal hyperon polarization depend on the vector and axial form factors. (tr-auth)

39352 USE OF DISPERSION RELATIONS IN THREE-PION DECAYS. Nutbrown, D. A. (Cambridge Univ., Eng.). Nuovo Cim., 56A: 479-92(July 21, 1968).

The method which replaces the soft-pion limit $k_\eta \to 0$ by $k^2 \to 0$ is extended to decays involving three pions. It is applied to the weak decays $K_2^0 \to 3\pi$, and the electromagnetic decays $\eta \to 3\pi$. In the former case a result is derived for the $K \to \pi$ amplitude which is compatible with previous estimates. In the latter case a value is derived for the absolute rate of $\eta \to \pi^+ + \pi^- + \pi^0$ which is an improvement over previous estimates. (auth)

39353 POSSIBLE EXPERIMENTS ON SEARCH FOR MIRROR K^0 MESONS. Nikolaev, N. N.; Okun, L. B. (Institut for Theoretical and Experimental Physics, Moscow). Phys. Lett., 27B: 226-9 (July 8, 1968).

A possibility to search experimentally for mirror K mesons is discussed. It is shown that, analyzing the photographs obtained during the neutrino experiment at CERN, one may put an upper bound for the amplitudes of interactions between the mirror particles and conventional ones. Detection of the K-meson decays, that are not related to stars on photographs, may be an indication to the existence of mirror K mesons. (auth)

Strong (General)

39354 (CERN-68-7(Vol.1)) TOPICAL CONFERENCE ON HIGH-ENERGY COLLISIONS OF HADRONS, CERN, GENEVA, 15-18 JANUARY 1968. (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 29, 1968. 656p. (CONF-680103-(Vol.1)). CERN.

This volume includes 25 review and invited papers one of which was abstracted previously in NSA. For an abstract of this paper see abstract number 22: 22297. Separate abstracts were prepared for 24 papers. (J.F.P.)

For abstracts of individual papers see: 39234, 39248, 39249, 39265–39272, 39314, 39355–39360, 39372, 39391–39393, 39491, and 39502.

39355 (CERN-68-7(Vol.1), pp 3-59) TOTAL CROSS SECTIONS AND ELASTIC SCATTERING NEAR THE FORWARD DIRECTION. Barger, V. (Wisconsin Univ., Madison. Dept. of Physics).

The theoretical status of interpretations of recent experimental data on elastic scattering is summarized. The classes of interactions considered are Coulomb−nuclear interference, total cross sections, small-angle elastic differential cross sections, and polarization measurements. Evaluation is made of the concepts of dispersion relations, symmetry and universality principles, Regge pole and diffraction models, and asymptotic boundary conditions. (J.F.P.)

39356 (CERN-68-7(Vol.1), pp 218-51) PHENOMENOLOGICAL THEORIES OF TWO-BODY COLLISIONS AT HIGH ENERGY, ESPECIALLY INELASTIC COLLISIONS. Bialas, A. (Jagellonian Univ., Krakow (Poland). Inst. of Physics. Institute of Nuclear Physics, Krakow (Poland)).

The Regge pole and other models are considered phenomenologically for two-body reactions at high energies. It is concluded that the Regge pole model or the investigation of singularities in the complex j-plane represents the richest and most appropriate framework for discussion of high-energy two-body processes. But as the discussion becomes more complicated this model loses most of its predictive power, thus other possibilities should also be investigated. The quark model is suggested as a good possibility since its properties are in a way complementary to those of the Regge pole model. (J.F.P.)

39357 (CERN-68-7(Vol.1), pp 380-412) THEORETICAL MODELS OF PRODUCTION PROCESSES AT HIGH ENERGY. Chan, Hong-mo (European Organization for Nuclear Research, Geneva (Switzerland)).

The review is confined to recent developments which have a direct bearing on present or future experiments at machine energies. The models discussed are the bremsstrahlung, thermodynamic, quark and multi-Regge models. The multi-Regge

model is mainly considered. The applications to three-body reactions and to multiple production are also included. (J.F.P.)

39358 (CERN-68-7(Vol.1), pp 441-59) GENERALIZED SUPERCONVERGENCE RELATIONS AS A GUIDE TO HIGH ENERGY SCATTERING OF HADRONS. Igi, Keiji; Matsuda, Satoshi (Tokyo Univ. (Japan). Dept. of Physics).

The review of generalized superconvergence relations as a guide to high-energy scattering of hadrons covers generalized superconvergence relations, applications to $B^-(\nu)$, $B^+(\nu)$ and $f^+(\nu)$, and ghost-eliminating zeros in the Regge pole model. The low-energy integrals in the narrow-width approximation are calculated. It is emphasized that the generalized superconvergent sum rule for an amplitude controlled by only one Regge pole is particularly useful for pinning down the zeros which are characteristic in the Regge formula and for tracing out the trajectory. (J.F.P.)

39359 (CERN-68-7(Vol.1), pp 471-7) AXIOMATIC PROOF OF SUPERCONVERGENCE RELATIONS. Mahoux, Gilbert; Martin, Andre (State Univ. of New York, Stony Brook).

The proof that the bound on the forward scattering amplitude for scalar particles originally derived by Froissart from the Mandelstam representation is in fact a consequence of axiomatic field theory and unitarity is considered. The proof is given for the scalar case and extended to the case of particles with spin. Since only stable particles can be considered in field theory the results apply to $\pi + d$ but not to $\pi + \rho$ interactions. (J.F.P.)

39360 (CERN-68-7(Vol.1), pp 478-93) PROBLEMS CONNECTED WITH HIGH ENERGY SCATTERING NEAR THE FORWARD DIRECTION. Salin, Ph. (European Organization for Nuclear Research, Geneva (Switzerland)).

Problems in the Regge pole model for high-energy scattering near the forward direction are considered. Conspiracy for nucleon-nucleon scattering, s-channel helicity amplitudes for exchange models, and the phenomenological analysis with pion conspiracy are discussed. (J.F.P.)

39361 (CERN-68-7(Vol.2), pp 45-54) GROUP THEORETICAL APPROACH TO THE CONSPIRACY PROBLEM FOR ARBITRARY MASSES. Cosenza, G. (Naples Univ. (Italy). Istituto di Fisica. Rome Univ. (Italy). Istituto di Fisica); Sciarrino, A. (Rome Univ. (Italy)); Toller, M. (European Organization for Nuclear Research, Geneva (Switzerland)).

Families of Regge trajectories are built with well-defined quantum numbers and factorized residues, whose contribution to an arbitrary number of reactions, with arbitrary masses and spins, satisfies all the constraints of analyticity and Lorentz invariance in a neighborhood of $t = 0$. The analytic properties of the amplitude are treated explicitly, and the connection due to factorization between equal-mass and unequal-mass reactions is discussed. (J.F.P.)

39362 (CERN-68-7(Vol.2), pp 93-101) HIGH-ENERGY AND HIGH-MOMENTUM TRANSFER COLLISIONS OF HADRONS. Kastrup, Hans A. (Munich Univ. (West Germany)).

A brief critical analysis is given of two basic assumptions for hadron collisions with very large momentum transfers in a specific framework which implies some experimental predictions. These assumptions are that such interactions give information about the short-range properties of the various types of interactions and that the main bulk of secondaries is a consequence of the rearrangement of the long-range parts of the hadronic fields. (J.F.P.)

39363 (CERN-68-7(Vol.2), pp 102-9) MULTIPARTICLE PRODUCTION IN A SOFT PARTICLE EMISSION MODEL. Giovannini, A.; Predazzi, E. (Turin Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Turin (Italy)).

The main results obtained in the framework of a multi-soft-particle emission model based on group-theoretical arguments are reviewed and extended. The limitations of the model are briefly discussed and also its possible generalizations. (J.F.P.)

39364 REGGEON DIAGRAM METHOD FOR INELASTIC PROCESSES WITH ARBITRARY NUMBER OF PARTICLES. Kancheli, O. V. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 7: 1119-26(May 1968). (In Russian).

Rules for writing the contribution of any Reggeon diagram to the inelastic process amplitude directly in terms of the reaction channel, are derived. The behavior of contributions of different Reggeon diagrams to inelastic amplitudes is considered. A simple method to calculate the total cross sections of inelastic processes described by Reggeon diagrams is presented. (auth)

39365 A TEST FOR SPIN DETERMINATION IN THREE BODY PARITY CONSERVING DECAYS OF THE TYPE $s \rightarrow \frac{1}{2} + 0 + 0$. Kozlowski, M. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 353-7(1968).

Decays of elementary particles or resonances of the type $x \rightarrow a + b + c$, where x denotes the resonance or elementary particle with unknown parity and spin, are considered. It is assumed that the intrinsic quantum numbers of all remaining particles are known. A test of such a three-body decay is described in which parity is conserved. This test uses the representation developed previously by Werle for many-particle systems, and requires the full analysis of the angular distribution of the normal to the decay plane. Due to the relatively simple structure of the test, it gives a crude but good method for the determination of the spin of particle x decaying into three particles when parity is conserved. (J.F.P.)

39366 DECAYS OF POLARIZED PARTICLES OF ARBITRARY SPIN. Zaman, Arif-Uz (Middle East Technical Univ., Ankara). Nuovo Cim., 56A: 493-523(July 21, 1968).

The differential rates for certain two-particle decays of polarized baryons and bosons of arbitrary spins were calculated in terms of the phenomenological coupling constants. The decay into a nucleon and a pseudoscalar meson was treated for the general parity-violating case. The baryon decay into a spin-$\frac{3}{2}$ particle and a pseudoscalar meson or a vector boson, and the boson decay into a vector boson and a pseudoscalar meson were calculated in the parity-conserving case. The Wigner-Bargmann equation was used to describe particles of higher spins and certain results connected with them, such as particle, antiparticle and spin projection operators and the density matrix was also derived. (auth)

39367 ANALYSIS OF SCATTERING IN THE QUARK MODEL. Barnhill III, Maurice Victor. Stanford, Calif., Stanford Univ., 1967. 100p.

Thesis.

Two calculations in the quark model are given. In the first, the linear parametrization of the hadron-hadron total scattering cross sections at high energy given by the additive quark model of Levin and Frankfurt and of Lipkin and Scheck is compared with experiment by a least-squares analysis using several different kinematic assumptions. The results indicate that improvement of the parametrization is desirable. Expressions for the corrections to the scattering cross sections due to shadowing and double-scattering processes are therefore obtained. The corrections are estimated to be large enough to be important, and a nonlinear parametrization obtained by including terms to represent the shadowing corrections is compared with experiment by a least-squares analysis. The agreement is then good under two different kinematic assumptions. It is also found that there is a good agreement using the linear parametrization and the kinematic assumptions of James and Watson. In all cases studied, the amplitude for the scattering of a λ quark from a nonstrange quark is significantly lower than the amplitude for the scattering of two nonstrange quarks. In the second calculation, a model due to Schiff which accounts for the binding of quarks in terms of large, many-body potentials is extended to allow a semiqualitative discussion of scattering. It is found that, keeping only one-, two-, and three-body forces, the range of the repulsive three-body force must be larger than that of the attractive two-body force. As a result the hard core in nucleon-nucleon scattering appears naturally. It should be observed, however, that the presence of a large, relatively long-range many-body interaction is difficult to reconcile with the results of the calculation of the high-energy scattering cross section, since that calculation assumes that two-body forces predominate. (Diss. Abstr.)

39368 FIELD THEORETICAL APPROACH TO COMPOSITE PARTICLES. Jouvet, Bernard (College de France, Paris). pp 87-255 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

A precise definition of a composite particle is sought which should express not only the solubility but should also be capable of giving results connected with observable phenomena. The definition of the composite particle, observable properties of the composite character, generalization of the compositeness equations to the case of many particles with the same quantum numbers, mass equations and the various types of composite particles, allo-composite relativistic particles, and the theory of autocomposite fields are treated. It is found that the field theoretical approach allows one to express in a simple mathematical way the concept that each composite particle is composed of other particles as well as of itself, no particle being therefore more elementary than the others. There is the possibility that some fields, although composite, may be more fundamental in the construction of discrete states of matter, and that these basic composite fields are not necessarily directly associated with observable particles. (J.F.P.)

39369 REMARKS ON PION CONSPIRACY. Froggatt, C. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., B6: 421-9(1968).

The contributions of an evasive and conspiring Regge-pion pole are contrasted for various reactions. It is concluded that the data are inconsistent with factorization for pion exchange. (auth)

39370 EQUAL-TIME IRREDUCIBLE-CURRENT COMMUTATORS AND DISPERSION RELATIONS. Tchrakian, D. H. (Westfield Coll., London). Nuovo Cim., 56A: 302-14(July 21, 1968).

A reformulation of Fubini's analysis of current algebra dispersion-relation sum rules is given such that the M-function of the scattering process transforms according to the irreducible representations (I.R.) (1, 1) of the quantum-mechanical homogeneous Lorentz group (H.L.G.). The formulation may easily be generalized to systems of any spin. The irreducible currents are introduced in the formulation, which transform according to the I. R. (1, 0) of H. L. G., and one possible model for the equal-time current commutator is considered. (auth)

39371 BOUND-STATE OPERATOR IN THE LEE MODEL. Zimmerman, R. L. (Univ. of Oregon, Eugene). Nuovo Cim., 56A: 391-402(July 21, 1968).

The form of the bound-state operator describing the V-θ composite state is investigated. A general class of operators having the quantum numbers of the composite state is constructed. By means of an asymptotic assumption and the reduction formula, the matrix elements for the V-θ composite state are calculated. It is shown that the physical properties of the composite state are independent of the form of its bound-state operator. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 39330, 39396, and 39405.

39372 (CERN-68-7(Vol.1), pp 595-8) $\pi\pi$ SCATTERING EFFECTS IN $p\bar{p}$ ANNIHILATIONS AT 2.5 GeV/c. Clayton, J.; Mason, P.; Muirhead, H.; Renton, P. (Liverpool Univ. (England)). Nuclear Physics Research Lab.).

The poor fit obtained to $\pi\pi$ effective mass distributions in the region of low $\pi\pi$ masses between 280 and 500 MeV in multipion systems when fitted with the conventional normalized phase space is studied. This pattern is observed in the reactions $\bar{p} + p \rightarrow 3\pi^+ + 3\pi^- + \pi^0$ at 1.2 GeV/c, $\bar{p} + p \rightarrow 2\pi^+ + 2\pi^- + \pi^0$ at 1.2 GeV/c, and $\pi^+ + p \rightarrow p + 3\pi^+ + 2\pi^-$ at 5 GeV/c. To illustrate the nature of these effects, the ratio R = (number of $\pi\pi$ entries in the histogram)/(number predicted from phase space) is plotted against the $\pi\pi$ effective mass for the data given. The rise of R above 1 in the region of mass 750 MeV is an indication of meson (ρ) production. A possible way to parametrize this effect is to regard it as a $\pi\pi$ scattering effect. The variation of phase shifts with energy is of the correct shape to interpret the departure of R from unity as a $\pi\pi$ scattering effect. (J.F.P.)

39373 (CERN-68-7(Vol.2), pp 281-302) SEARCH FOR MESON RESONANCES IN HIGH MULTIPLICITY PROCESSES. Clayton, J.; Mason, P.; Muirhead, H.; Renton, P. (Liverpool Univ. (England). Nuclear Physics Research Lab.).

Data from measurements of $p + \bar{p} \rightarrow 3\pi^+ + 3\pi^-$ interactions at 2.5 GeV/c are presented. Invariant mass distributions are plotted for $(2\pi^+ + 2\pi^-)$ mesons; there are nine possible combinations per event. Small peaks are seen at 1.6, 1.7, and 1.8 GeV. Confidence in their existence is reinforced by imposing a cut which demands the system $X \rightarrow \rho^0\rho^0 \rightarrow 2\pi^+ + 2\pi^-$ decay, where the ρ^0 is defined as a $\pi^+\pi^-$ combination with mass in the interval 660 to 810 MeV. Also the possibility of Δ (1236) production is considered. The analysis suggests that the two pions produced with the resonances are separate entities, and thus the three data for the channel $p + \bar{p} \rightarrow 3\pi^+ + 3\pi^-$ would appear to support the three meson hypothesis. (J.F.P.)

39374 SLOPE OF THE $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ D-WAVE BELOW THRESHOLD. Common, A. K. (Kent Univ., Canterbury, Eng.). Nuovo Cim., 56A: 524-30(July 21, 1968).

The derivative of the $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ D-wave amplitude is investigated for $0 \leq s < 4$, using dispersion relations valid in axiomatic field theory, crossing, and positivity properties due to unitarity. It is shown that this derivative is negative when $1.742 \leq s < 4$. (auth)

39375 RELATIVISTIC MODEL FOR KINEMATICAL FORM FACTORS. Benecke, J.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 56A: 269-301(July 21, 1968).

The vertex functions to be used in the peripheral model are studied and the vertex of two pseudoscalar mesons coupled to a spin-j resonance is treated. A nonlocal coupling is introduced by considering the j-th partial-wave projection of an inhomogeneous Bethe-Salpeter equation in the ladder approximation (exchange of mass-$\varkappa$ scalar boson). An approximate resonance solution of this equation is expressed in terms of the first Fredholm determinants, and vertex functions V_j are derived. By interpolating between several partial waves according to the Regge model the form factor V_j/V_0 is obtained which for relative momentum $|P| \rightarrow 0$ or for $\varkappa \rightarrow \infty$ (local coupling) turns into the Born-term vertex function ($\propto |P|^j$) and for $|P|/\varkappa \rightarrow \infty$ goes to 1. This V_j/V_0 is called a kinematical form factor, because it is equal to 1 for $j = 0$. In the case of peripheral processes with pseudoscalar-meson exchange it corresponds to the nonrelativistic penetration factor considered by Dürr and Pilkuhn. But moreover it can be continued analytically into the crossed channel corresponding to spin-j exchange peripheral processes. The mass $\varkappa$ is a fitting parameter. (auth)

39376 USE OF A SPINLESS TARGET FOR DETERMINATION OF SPIN AND PARITY OF THREE-PARTICLE RESONANCES. Dubovikov, M. S. (Moscow Physical-Technical Inst.). Yadern. Fiz., 7: 1127-30(May 1968). (In Russian).

A boson resonance B with spin j is considered that decays with parity conservation into three particles and is produced in a parity conserving reaction $0 + 0 \rightarrow j + 0$ (0 and j are spins of the particles). It is shown that using the symmetry properties of the B production in the angular analysis of its decay products one may establish the spin and the parity of B with more certainty. Relations between the observed effects for $j = 1, 2$ are obtained. (auth)

39377 PROCESSES $pn \rightarrow np$, $\bar{p}p \rightarrow n\bar{n}$ AND BRANCHING IN J-PLANE. Kaidalov, A. B.; Karnakov, B. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern Fiz., 7: 1147-9(May 1968). (In Russian).

It is shown that experimental data on reactions $pn \rightarrow np$ (I) and $\bar{p}p \rightarrow n\bar{n}$ (II) at high energies can be described by the method of complex momenta considering the branching in the j-plane. However, descriptions of these processes by the Regge pole models are complicated. Therefore additional poles (ρ' or R') with $\alpha(0) \approx -0.20$ are introduced. It is also impossible to describe the behavior of differential cross sections of reactions (I) and (II) as functions of t. The observed difference in differential cross sections of reactions (I) and (II) was found to be related to the interference of π-meson cross section and Regge ρ-pole. Using simplified models which take into account the branching and which do not exhibit a definite parity, it was possible to explain the qualitative difference in the differential cross sections of processes (I) and (II) and, also, to explain the variations of differential cross sections of process (I) with variations of energy at $t = 0$. It was also noticed that even considering A(s,t) (which are contributed by the ρ, R) the differential cross sections of processes (I) and (II) can differ at $t = 0$. Further detailed analysis may demand the consideration of the R trajectory. (R.V.J.)

39378 REGGEIZED BOOTSTRAP BASED ON FINITE-ENERGY SUM RULES AND UNITARITY. Igi, Keiji (Tokyo Univ.). Phys. Rev. Lett., 21: 184-6(July 15, 1968).

A new Reggeized bootstrap scheme is proposed based on finite-energy sum rules and unitarity. Taking a simple ρ,f bootstrap model in $\pi\pi$ scattering as an example, both the high- and low-energy amplitudes are calculated simultaneously. (auth)

39379 GAUGE-FIELD ALGEBRA WITH SYMMETRY BREAKING. Kimel, I. (Univ. of Chicago). Phys. Rev. Lett., 21: 177-80(July 15, 1968).

It is shown that in gauge-field models for the electromagnetic and weak hadronic currents, restrictions are imposed on the way the symmetry is broken if the algebra of currents is to hold. A modified form of Weinberg's second sum rule is proposed, and relations among vector-meson masses are obtained on the assumption of nonet symmetry for the currents. (auth)

39380 PADE APPROXIMANTS IN STRONG INTERACTIONS TWO-BODY PION AND KAON SYSTEMS. Basdevant, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Bessis, D.; Zinn-Justin, J. Phys. Lett., 27B: 230-3(July 8, 1968).

The theory of Padé approximants is applied to the study of strong coupling of meson systems involving pions and kaons. Starting with three parameters corresponding to $\pi\pi$, πk, and kk elastic amplitudes at the maximum-symmetry points, crossing symmetry and unitarity are repeatedly applied. Two-body resonances and Regge trajectories are computed; the masses obtained for ρ, f_0, f_0', k*(890), k*(1415), ϕ, and A_2 are within a few percent of their experimental masses. (L.B.S.)

39381 EXCHANGE DEGENERACY AND BACKWARD SUPERCONVERGENCE IN $N\bar{N}$ SCATTERING. Roy, D. P. (Univ. of California, Riverside). (Phys. Rev. Lett., 21: 119-21(July 8, 1968).

The treatment of a weak u channel by the usual prescription of exchange degeneracy, based on a potential-theory model, is shown to violate crossing badly. On the other hand, a crossing-symmetric treatment of the same situation would lead to backward superconvergence relations, which provide the basis for a new prescription of exchange degeneracy. Several consequences of this crossing-symmetric prescription of exchange degeneracy are discussed, with particular reference to $N\bar{N}$ scattering. (auth)

39382 PRODUCTION OF THREE PIONS IN $\bar{p}p$ ANNIHILATIONS AT REST. Foster, M. (CERN, Geneva); Gavillet, Ph.; Labrosse, G.; Montanet, L.; Salmeron, R. A.; Villemoes, P.; Ghesquiere, C.; Lillestoel, E. Nucl. Phys., B6: 107-24(1968).

Results are presented on annihilations of antiprotons at rest in hydrogen to the $\pi^+\pi^-\pi^0$ final state. The analysis leads to the following general conclusions: (a) The reaction $\bar{p}p \rightarrow \pi^+\pi^-\pi^0$ accounts for $(6.9 \pm 0.4)\%$ of the total number of annihilations. (b) 84% of the reaction proceeds from the $^3S_1$ initial state which, by spin, parity and isospin conservation, leads to odd angular momenta between two pions in the final state. It is found that this channel is dominated by the $\rho\pi$ production. (c) 16% of the reaction proceeds from the $^1S_0$ initial state. Although the $^1S_0$ state may lead to odd and even angular momenta between two pions, no P-wave dipion contribution was found, while 4% of the reaction is attributed to $f^0\pi^0$ production. (d) A satisfactory interpretation of the data requires, besides the simple final state interaction model, the introduction of a direct three-pion production amplitude. (e) 12% of the reaction is attributed to S-wave dipion production. No dynamical structure was found in this channel and only upper limits for σ and ϵ production are given. (auth)

39383 TWO-PION EXCHANGE EFFECTS ON NN AND $N\bar{N}$ FORWARD ELASTIC SCATTERING AMPLITUDES BELOW PHYSICAL THRESHOLD AND ON N ISOVECTOR FORM FACTORS. Young, Robert Donald. Lafayette, Ind., Purdue Univ., 1967. 154p.

Thesis.

A dispersion-theoretic calculation of the effects of two-pion exchange on the NN and $N\bar{N}$ forward elastic scattering amplitudes below the physical thresholds is performed. The two-pion exchange effects on the nucleon isovector form factors are also analyzed by dispersion theory in order to obtain statistically good fits to the latest $G^V_{E,M}$ data for momentum-transfer squared below $-1(\mathrm{BeV/c})^2$. The ρNN coupling is determined from the fits. (TSS) (Disser. Abstr.)

39384 A THEORY OF $\pi - A_1$ MIXING AND THE PION MASS DIFFERENCE. Munczek, Herman; Brown, L. M. (Northwestern Univ., Evanston, Ill.). pp 327-37 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

A phenomenological approach for a particle system restricted to the mesons (ρ), (A_1), and (π) is discussed. This approach has the following characteristics: The mesons (A_1) and (π) are mixed in a way suggested by the hypothesis of meson dominance of the axial current. Correspondingly, it is assumed that the conserved vector current is dominated by the (divergenceless) rho meson field. The phenomenological Lagrangian techniques are used, in particular, tree diagrams, effective photon propagator, etc. Chiral symmetry is not required. The decay rates of the mesons (ρ) and (A_1) and the mass difference between charged and neutral pions are calculated. (J.F.P.)

39385 $K_{\mu 4}$ DECAY AND $\pi - \pi$ SCATTERING. Maksymowicz, Alexander (Univ. of California, Santa Cruz. Univ. of Pittsburgh). Contract AT(30-1)-3829. pp 383-92 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

An outline of the analysis of previous work on $K_{\mu 4}$ decay, which was proposed as a very suitable process for determining the parameters of the S-wave $\pi + \pi$ interaction near threshold, since the only hadrons in the final state of this reaction are two pions, is presented. Special attention is given to the assumptions involved. The discussion is restricted to the decay mode $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$. (J.F.P.)

39386 SCALAR MESON WIDTHS. Micu, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B6: 367-72 (1968).

The widths of scalar mesons are evaluated in the approximation of soft-meson emission, assuming that the equal-time commutator between an axial charge and an axial divergence is proportional to scalar meson fields. (auth)

39387 $\pi\pi$-PHASE SHIFT EXTRACTION FROM K_{e4}. Pais, Abraham (Rockefeller Univ., New York). pp 7-17 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

It is found that the K_{l4} provides the best way known to obtain the $\pi\pi$ phase shifts for $s_\pi = 4-12\ m_\pi^2$. It is pointed out that the two π's emitted in the decay are essentially free pions. The intensity of the spectrum is discussed. The consequences of pair locality, and extraction of the $\pi-\pi$ phase shifts from K_{e4} are considered. (J.F.P.)

39388 EFFECTS OF FORM-FACTORS AND POLARIZATION IN $\bar{p} + n \rightarrow W^- \rightarrow l + \bar{\nu}_l$ REACTION. Kerimov, B. K.; Kasumov, Yu. M.; Yakh'yaev, R. Sh. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 83-9(1968). (In Russian).

Formulas were obtained for differential and total cross sections of weak lepton annihilation of antiprotons and neutrons taking into account, simultaneously, the boson, weak nucleon current form factors and arbitrary polarization of the initial particles. For the contact interaction $(V-\lambda A)$ it is shown that the cross section of the process is quite sensitive to the axial interaction structure and to the particle spin correlation. (tr-auth)

39389 NEUTRAL THEORY MODELS OF S-WAVE $\pi - \pi$ SCATTERING FULFILLING RIGOROUS CONDITIONS. Wanders, G.; Piguet, O. (Univ., Lausanne, Switzerland). Nuovo Cim., 56A: 417-36(July 21, 1968).

Models of the low-energy S-wave $\pi^0 - \pi^0$ scattering amplitude in the neutral theory are constructed. In the nonphysical interval $0 \leq s \leq 4$, these models satisfy conditions which have been deduced rigorously from axiomatic field theory. The models are based on a parametrization of the inverse K-matrix element $\varphi(s) = \frac{1}{2}(s-4)^{\frac{1}{2}}$ ctg $\delta(s)$ which is consistent with its analyticity properties and its threshold behavior at $s = 0$. Three models are investigated, characterized by the number of poles of $\varphi(s)$. In each case, the values of the parameters are strongly restricted. Systematically, some rigorous inequalities are nearly saturated. The results have no direct extension to the realistic charged theory. (auth)

39390 PION–PION SCATTERING. Treiman, Sam (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 2: 68-73(May-June 1968).

The direct pion-pion scattering information obtainable by use of the OPE model, current algebra, and PCAC is discussed. Present attempts at extracting information on the $\pi-\pi$ phase shifts from its effects in other processes, such as the $\pi + N \rightarrow \pi + \pi + N$ interaction and $K \rightarrow 2\pi$ decays, are discussed. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 39323, 39324, 39330, 39332, 39372, and 39715.

39391 (CERN-68-7(Vol.1), pp 460-70) πN RESONANCES AND BACKWARD SCATTERING. Hoegaasen, H. (Paris Univ. (France). Institut de Physique Nucleaire).

Some aspects of πN resonances and backward scattering are discussed in the framework of the Regge pole model. The resonance formation channel, called the u-channel (u denotes the square of the total cms energy), and the channel where high-energy backward scattering is studied, called the s-channel (s denotes the cms energy squared) are considered. (J.F.P.)

39392 (CERN-68-7(Vol.1), pp 494-522) REGGE FAMILIES IN BROKEN SL/2,C/. Domokos, G.; Suranyi, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest).

An elementary exposition of some algebraic methods in Regge theory leading to the classification of Regge poles according to a trajectory generating algebra SL(2,C) at zero momentum transfer is given. The classification is extended to nonvanishing momentum transfers leading to a universal classification of Regge trajectories. The theory is applied to the phenomenological classification of the nucleon and delta trajectories. (auth)

39393 (CERN-68-7(Vol.1), pp 611-47) REACTIONS PRODUCING THREE FINAL PARTICLES AND COMPARISON OF THE DOUBLE REGGE POLE MODEL WITH SOME EXPERIMENTAL DATA. Ratti, S. (Milan Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Milan (Italy)).

Some predictions of the double Regge pole model as given by Chan et al., (Nuovo Cimento, 49A, 157(1967)) and N. F. Bali et al., (Phys. Rev. Lett., 19, 614(1967)) are compared with experimental data coming from an extensive π^- + p experiment at 11 GeV/c. The analysis indicates that the double Regge pole model might be the correct way to describe many-body processes. (J.F.P.)

39394 (CERN-68-7(Vol.2)) TOPICAL CONFERENCE ON HIGH-ENERGY COLLISIONS OF HADRONS, CERN, GENEVA,

15–18 JANUARY 1968. (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 29, 1968. 305p. (CONF-680103-(Vol.2)). CERN.

This volume includes 19 contributed papers three of which were abstracted previously in NSA. For abstracts of these papers see abstract numbers 22: 9588, 22: 15670, and 22: 15850. Separate abstracts were prepared for 16 papers. (J.F.P.)

For abstracts of individual papers see: 39250, 39273–39279, 39298, 39361–39363, 39373, and 39395–39397.

39395 (CERN–68-7(Vol.2), pp 55-73) PHASE CONTOURS OF SCATTERING AMPLITUDES. Chiu, Charles B. (European Organization for Nuclear Research, Geneva (Switzerland)); Eden, Richard J.; Tan, Chung-i (California Univ., Berkeley. Lawrence Radiation Lab.).

The method of phase contours and its application to some problems in strong interactions are described. Phase contours are curves along which the phase of a scattering amplitude is constant. They are sections of complex surfaces in the space of the invariants s, t, and u. A brief discussion is given of the properties of phase contours, phase contours for pion–nucleon scattering, phase contours in a Regge model for pion–nucleon scattering, resonance poles and zeros in a crossing symmetric model, and fixed-angle scattering at high energy. (J.F.P.)

39396 (CERN–68-7(Vol.2), pp 110-13) TOTAL CROSS-SECTIONS IN THE MULTI REGGE MODEL. Finkelstein, J.; Kajantie, K. (European Organization for Nuclear Research, Geneva (Switzerland)).

Some results on integrated cross sections in the multi Regge model are reported. Details and proofs are not presented. The simplest cases for which these results could be applied are those for which, as n increases one adds more vertices of the type already present. An example is $K^- + p \to (n\pi) + Y$, where Y is constrained to emerge from the proton vertex; then in the limit of exchange degeneracy only the K^* trajectory can be exchanged. Other examples are $\pi^+ + p \to K^+ + Y + (n\pi)$, $p + \bar{p} \to (n\pi)$, $p + \bar{p} \to Y + \bar{Y} + (n\pi)$, and $K^- + p \to (n\rho^0) + Y$. (J.F.P.)

39397 (CERN-68-7(Vol.2), pp 150-71) FURTHER ANALYSIS OF $N^*\rho$ AND $N^*\omega$ QUASI-TWO-BODY REACTIONS BY 5 GeV/c π^+ MESONS ON PROTONS. Boeckman, K.; Rost, M.; Sternberger, K. (Bonn Univ. (West Germany). Physikalisches Institut); (and others).

Preliminary results of a detailed analysis of the reactions $\pi^+ + p \to \Delta^{++} + \rho^0(\omega^0)$ at 5 GeV/c are presented. The differential cross section as a function of $|t - t_{min}|$ ($|t_{min}|$ being the minimum value of |t| allowed by the masses at both vertices), the constraints implied on the single-vertex density matrix elements by the positivity of the spin density matrix (as a function of |t|), and preliminary results of an attempt to evaluate the effect of background on the spin–density matrix element are discussed. Also discussed are the results of an evaluation of the average value of all joint decay density matrix elements (including those expressing correlations between the two vertices) and a study of the evaluation of these elements as a function of $|t - t_{min}|$, and a test of the relations between the spin–density matrix elements obtained by the quark model and the additivity assumption. (J.F.P.)

39398 (IC–68/48) CONTINUOUS-PARAMETER SUM RULES. Taha, M. O. (International Centre for Theoretical Physics, Trieste (Italy)). June 1968. 16p. Dep.

Using Laplace transform and Regge high-energy behavior, continuous-parameter sum rules are found for strong interaction amplitudes. The finite-energy version of these sum rules is discussed and equations for the Regge parameters obtained. Forward πN scattering is considered as an example and numerical values are found for the parameters of ρ and ρ' trajectories. A mathematical appendix on the incomplete gamma function is added. (auth)

39399 (IC–68/51) ARGAND DIAGRAMS AND RESONANCES. Alessandrini, V. A.; Freund, P. G. O.; Oehme, R.; Squires, E. J. (International Centre for Theoretical Physics, Trieste (Italy)). June 1968. 11p. Dep.

It is shown that the Argand analysis of Regge amplitudes would give rise to "resonances" with low masses and high spins if the interpretation of maxima as resonances were accepted. Theoretical and experimental consequences are discussed. (auth)

39400 (ITF–67-54) ALGEBRA BARIONNYKH TOKOV V MODELI SVOBODNYKH EFFEKTIVNYKH KVARKOV. (Baryon Current Algebra in the Model of Free Effective Quarks). Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 19p. (In Russian). Dep.

It is proved that the commutation relations of the current algebra for baryons are valid in the model of free effective quarks to any order in the inverse baryon mass. (auth)

39401 (JINR–P2-3802) SVERKHPROVODIMOST' V MODELI KVARKOV I TRAEKTORII REDZHE. (Superconductivity in the Quark Model and Regge Trajectories). Malyuta, Yu. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 8p. (In Russian). Dep.

It is shown that reggeons, representing two families of baryon resonances ($N(1525^-)$, $N(2190^-)$, $N(2650^-)$, $N(3030^-)$), and ($\Delta(1236^+)$, $\Delta(1920^+)$, $\Delta(2420^+)$, $\Delta(2850^+)$, $\Delta(3230^+)$), are the states of superconductive type, which are constructed of three quarks with zero masses. (auth)

39402 (JINR–P2-3820) O VOZMOZHNOM DEKUPLETE BARIONNYKH REZONANSOV $5/2^+$. (On a Possible Decuplet of Baryon Resonances $5/2^+$). Gere, F.; Enkovski, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 6p. (In Russian). Dep.

A possible decuplet of baryon resonances $\frac{3}{2}^+$ is investigated: decay rates of processes of the type $\frac{3}{2}^+ \to \frac{1}{2}^+ + 0^-$ are calculated, comparison with experiment is carried out. (auth)

39403 (JINR–P2-3850) REAL PART OF THE ELASTIC πN- AND NN-SCATTERING AMPLITUDE. Barashenkov, V. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 8p. (In Russian). Dep.

Graphs are given of the energy dependence of the ratio of real and imaginary parts for the elastic $\pi^+ + p$, $\pi^- + p$, $p + n$, and $p + p$ scattering amplitudes at zero angle in the energy range from 50 MeV up to 200 GeV. (auth)

39404 (N–68-21629) STRUCTURE OF THE EQUAL TIME ANTICOMMUTATOR OF THE BARYON CURRENT IN NEUTRAL PSEUDOSCALAR MESON THEORY. Tapper, M. L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 23p. (NASA-TM-X-63165). CFSTI.

The equal time anticommutator of the baryon current which is the source term of the Dirac equation is studied for the case of a neutral pseudoscalar meson interaction. A method of calculating the equal time anticommutator is given which incorporates the basic structure arising out of the Wilson hypothesis used to define the current. It is found that derivatives of $\delta^3(x - x')$ do not appear in the anti-commutator. The absence of such Schwinger terms permits a theorem to be stated regarding the high energy behavior of the spectral functions which characterize the baryon propagator. (auth) (STAR)

39405 (TPJU–15/67) SIMPLE METHOD OF PRESENTING JOINT DECAY DISTRIBUTIONS FOR PAIRS OF RESONANCES. Kotanski, A.; Zalewski, K. (Jagellonian Univ., Krakow (Poland). Dept. of Theoretical Physics). Sept. 1967. 27p. Dep.

Statistical tensors are used to describe decay distributions of resonances and joint decay distributions of pairs of resonances. General formulas are derived and their use is illustrated by examples (for ρ, N^*, ρN^*, N^*N^*, $N^*\bar{N}^*$). (auth)

39406 (TPJU–19/67) SYSTEMATICS OF THE RELATIONS FOLLOWING FROM THE QUARK MODEL. II. CONSTRAINTS ON DECAY DISTRIBUTIONS OF RESONANCES. Bialas, A.; Zalewski, K. (Jagellonian Univ., Krakow (Poland). Dept. of Theoretical Physics). Dec. 1967. 26p. Dep.

Decay distributions of the resonances produced in quasi-two-body processes are discussed in the framework of the generalized quark model. Only results which can be obtained without comparing different reactions are considered. The quark model relations among density matrix elements are divided into three groups differing in their behavior under changes of the spin reference frames. The relations contained in the first two groups are found to be consistent with the experimental data. The relations from the third group seem in disagreement with the data. A tentative interpretation of these results is given. (auth)

39407 (UCRL-Trans-1364) REGGE POLES AND THE OCCURRENCE OF RESONANCES IN πN and KN COLLISIONS. Kaidalov, A. B.; Karnakov, B. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by J. E. Bradley for Univ. of California Lawrence Radiation Lab., Berkeley, from report ITEF-520. 35p. Dep. CFSTI.

The reactions of resonance production in πN and KN collisions at high energies are investigated within the framework of the Regge pole model. It is shown that existing experimental data on the differential cross sections and the polarization density matrix elements at the different energies are in good agreement with the predictions of the model of several Regge poles. The role of the possible branching in the complex j-plane is discussed. The analysis shows, that the contributions of branches having no definite parity are negligible in the energy region of $\lesssim$10 GeV. (auth)

39408 LORENTZ-POLE ANALYSIS OF THE HIGH-ENERGY REACTION $\pi N \rightarrow \omega N_{\frac{3}{2}}^{*}(1236)$. Antoniou, N. G.; Komy, S. R.; Palev, C. D.; Samiullah, M. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim., 56A: 437-44(July 21, 1968).

The high-energy reaction $\pi N \rightarrow \omega N_{\frac{3}{2}}^{*}$ was investigated using the formalism of Delbourgo, Salam and Strathdee. It was found that the observed angular distribution may be understood if it is assumed that the $j_0 = 2$ component of the Lorentz pole associated with the ρ-trajectory is dominant at the neighborhood of the point $\alpha_\rho = 0$. (auth)

39409 DISPERSION RELATIONS WITHOUT SUBTRACTION AND DIVERGENT SUM RULES. Krasnopevtsev, E. A.; Chernyak, V. L. (Inst of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 7: 1114-18(May 1968). (In Russian).

Dispersion sum rules for the πN and KN scattering are considered. The agreement between the high-energy Regge behavior and low-energy parameters is found. It is shown that the sum rules are fulfilled starting from the total energy of the incident particle in lab. system $z \simeq 1.5$ GeV i.e., essentially beneath the Regge domain. The question is also discussed to what extent the sum rule based on the relation $(K^+p + K^-p) - \frac{1}{2}(K^+n + K^-n) = \frac{1}{2}(\pi^+p + \pi^-p)$ (consequence of the quark additivity), is fulfilled. (auth)

39410 QUARKS-ON-SPRINGS MODEL OF THE BARYONS. Shapiro, Joel A. (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 47: 439-67(May 1968).

The radiative decay of a charged harmonic oscillator is discussed from an algebraic point of view. The possibility of understanding decay widths of baryon towers in an analogous fashion is discussed. A very simple nonrelativistic model of quarks on springs is developed and found to give fairly good agreement to the decays of the Δ and $N_{\frac{3}{2}}^{*}$ trajectories. (auth)

39411 AN INVESTIGATION OF THE ACCURACY OF THE TOMONAGA INTERMEDIATE COUPLING APPROXIMATION. Horowitz, Joel Lawrence. Ithaca, N. Y., Cornell Univ., 1968. 91p.

Thesis.

The Tomonaga intermediate coupling approximation and a two-wave-function generalization of it are applied to the system consisting of charged, scalar mesons interacting with a static-source nucleon. The generalization allows mesons in the nucleon ground state to occupy either of two states in momentum space. Expressions are obtained for the ground-state wave functions and energy, and for the differential cross section for the elastic scattering of positive mesons by protons. A comparison of the results of the one- and two-wave-function approximations indicates that the Tomonaga approximation is able to accurately predict static properties of the ground state, such as its energy, but not scattering cross sections. A non-Tomonaga single-wave-function approximation for the ground state is derived from the two-wave function Tomonaga approximation. The scattering cross sections obtained with the non-Tomonaga approximation agree well with those obtained using the two-wave-function Tomonaga approximation. (Diss. Abstr.)

39412 REGGE POLE ANALYSIS OF PSEUDOSCALAR MESON–BARYON INELASTIC SCATTERING REACTIONS. Sarma, Kuruganti Veera Lakshmana. Madison, Wis., Univ. of Wisconsin, 1968. 168p.

Thesis.

An analysis of the inelastic reactions in pseudoscalar meson-spin-$\frac{1}{2}$ baryon scattering is made in the framework of Regge pole theory. The analysis indicates that the peripheral models based on boson Regge pole exchanges with SU(3) symmetry for vertices offer an adequate and consistent description of the available data. The observed minima in the differential cross section curves of various reactions of interest have a simple interpretation as consequences of the assumption that the helicity amplitudes vanish at the sense-nonsense and nonsense-nonsense points. Predictions of polarization of the final baryon at high energies are presented and found to be in accordance with the available data. By means of the interference model (Regge exchange plus direct channel resonances) it is shown that the data in the intermediate energy region on π^-p-charge exchange reaction can be explained by postulating the existence of a $I^3/_2^-$ resonance with a mass of 2530 MeV and with the quantum numbers $Y = 1$ and $I = \frac{1}{2}$. Detailed predictions of the neutron polarization are presented in the framework of interference model at intermediate energies. It is argued that, while sizeable deviations from the hypothesis of exchange degeneracy are to be expected, SU(3) symmetry is a useful symmetry for Regge pole analyses. The f/d ratios relating to the baryon–octet couplings with the vector mesons and tensor mesons are deduced in a way which is free from ambiguities. These ratios then enable one to predict the differential cross sections and polarizations at high energies for any inelastic scattering reaction which has only a pseudoscalar meson and spin-$\frac{1}{2}$ baryon in both the initial and final channels. (Disser. Abstr.)

39413 K^+n CHARGE EXCHANGE AND THE ρ' REGGE TRAJECTORY. Schwarzschild, Bertram Marcus. Berkeley, Calif., Univ. of California, 1967. 43p.

Thesis.

Finding that the Regge exchange of ρ and A_2 fails to describe the K^+n charge-exchange data at 2.3 GeV/c (the highest energy available to date) when a simultaneous fit is attempted with higher energy data on K^-p and π^-p charge exchange and $\pi^-p \rightarrow \eta^0 n$, a second, lower lying ρ-type trajectory (ρ') is introduced. This also provides a possible mechanism for the puzzling π^-p charge-exchange polarization. It is found that one is then able simultaneously to fit all these data (including the polarization), together with related total cross section differences up to 20 GeV/c, with a ρ' whose spin-1 mass is 1.0 GeV [perhaps the $\delta(965)$?] and whose $t = 0$ intercept, 1.1 units of angular momentum below the ρ, agrees roughly with the ρ' proposed by Högaasen and Fischer to describe forward $\bar{p}p$ and np charge exchange, where the (ρ, A_2) model also fails. The ρ and A_2 trajectories turn out to be essentially traditional. In the fit only small SU_3 breaking is allowed between the $\bar{K}K$ and $\pi\pi$ (or $\eta^0\pi^0$) couplings to the trajectories. The fit is further constrained to obey the sum rule of Igi and Matsuda. In fitting the K^+ data at 2.3 GeV/c, a deuteron correction is included, and exact Legendre functions are employed rather than the high-energy asymptotic Regge forms. Predictions for higher energy K^+ charge exchange are offered. (Disser. Abstr.)

39414 AN ANALYTICAL AND NUMERICAL STUDY OF THE BOUND STATE SOLUTIONS TO THE PION–NUCLEON BETHE–SALPETER EQUATION. Rothe, Klaus Dieter. Berkeley, Calif., Univ. of California, 1967. 156p.

Thesis.

The Bethe–Salpeter equation describing the interaction of pseudoscalar mesons and nucleons via pseudoscalar coupling is solved numerically for energies below the elastic threshold by use of variational techniques. Only the "ladder" approximation with a local potential corresponding to the exchange of an elementary nucleon is considered. Simple generalizations of this form of the interaction are considered as well. In the absence of a cutoff this leads to a marginally singular integral equation. The boundary conditions to be imposed on the solutions in order to lead to a discrete eigenvalue spectrum are examined in detail. The study of this problem is considerably simplified at zero total cm energy, where the (Wick rotated) equation is invariant under four-dimensional rotations. In order to take full advantage of this symmetry, a new set of spinor spherical harmonics belonging to the representations $[(n \pm 1)/2, n/2]$ and $[n/2, (n \pm 1)/2]$ is constructed of the four-dimensional rotation group. The discussion is then extended to the general case, in which the formal structure of the $E \neq 0$ solutions is examined briefly. Attention is given to the role of the "relative time" in a relativistic theory, and the closely related problem of arriving at a time-independent approximation of the BS equation. In particular, the static and nonrelativistic limit of the equation is considered, and the validity of the approximations involved is discussed. The eigenvalue spectrum obtained in the two limits is compared to that of the original equation. Finally, a brief discussion is given of the $N\theta$ and $V\theta$ sectors of the Lee model, designed to illustrate still further the observations on the role of the "relative time" in a relativistic theory. (Disser. Abstr.)

39415 REGGE SEQUENCES OF BARYONIC ISOMULTIPLETS. Zaikov, R. G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 191-4(1968).

Regge sequences of baryonic isomultiplets are calculated. Tables are given showing the isomultiplets and mean values. These tables include all available data on the mean values calculated from various reported values. The predicted isomultiplets are indicated. (J.F.P.)

39416 RHO–MESON SHAPE. Pisut, Jan; Roos, Matts (CERN, Geneva). Nucl. Phys., B6: 325-52(1968).

A detailed description is developed for the invariant dipion mass distribution in the reaction $\pi p \rightarrow \pi\pi N$. Based on OPEM and modified phenomenologically, this "generalized Breit–Wigner" formula accounts for peripheral production, t-dependence of the ρ parameters, skewness of the ρ peak, energy dependence of the ρ width, energy-dependent departure from OPEM, background, and the background interference. Contributions from other $\pi\pi$ partial waves are included and the possibility of ρ being a CDD pole considered. The formula is used on a data compilation of large statistics and conclusions concerning the presence of the various terms and the ρ parameters are reached. Finally the

width of the pion-produced ρ meson is compared with the width of the e^+e^- produced ρ meson. (auth)

39417 THE DECOMPOSITION OF BETHE–SALPETER AMPLITUDES INTO STANDARD COVARIANTS AND INVARIANT AMPLITUDES. Alpers, W. (Institut fuer Experimentalphysik, Hamburg). Nucl. Phys., B6: 353-66(1968).

The theory of standard covariants which depend on two four-vectors is developed in a systematic way. The decomposition of Bethe-Salpeter amplitudes for the bound state problem into standard covariants and invariant functions is given for the general spin case. Finally, this method of decomposing amplitudes is applied to the Bethe-Salpeter equation of the pion-nucleon system in the ladder approximation with nucleon exchange in order to reduce the spinor equation to a set of scalar integral equations for two invariant functions. (auth)

39418 SPONTANEOUS SYMMETRY-BREAKING MODEL FOR BARYON SPECTRUM. Szego, K. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 24: No. 1, 33-43(1968).

A Yukawa-type interaction of the baryon and meson octets is examined looking for a nonsymmetrical solution of the Dyson–Schwinger equations for the Green functions. The baryon masses are calculated in the framework of the model. The Σ and Λ masses turn out to be different, and the model accounts for the octet enhancement. To fix the numerical values the experimental value of the nucleon–pion interaction coupling constant, the average mass of baryons and one more masslike parameter are used. A good agreement with known baryon masses is obtained. (auth)

39419 VECTOR MESON DOMINANCE AND POLARIZATION. Fraas, H.; Schildknecht, D. (Deutsches Elektronen Synchrotron, Hamburg). Nucl. Phys., B6: 395-407(1968).

The vector dominance model relates amplitudes for reactions induced by photons (e.g., π-production from nucleons) to amplitudes for reactions induced by vector mesons. In the application of such relations one conventionally assumes that the vector mesons have to be polarized transversely with respect to the c.m. system. Because of the spin rotation of a massive particle under Lorentz transformations, this choice is not well justified a priori. The assumptions are made that the vector meson couples to a conserved current, and that for large s, the invariant amplitudes $A^{(i)}(s,t)$ (i = 1, . . . , 6) for π production from nucleons are approximately independent of the mass λ of the vector mesons. It is found that for large s the optimum approximation of the photoproduction amplitudes is obtained if the vector mesons are in the transverse helicity states (with respect to the c.m. system). Indeed, exactly these transverse amplitudes are independent of λ for $s \gg \lambda^2$, if the contribution of $A^{(6)}(s,t)$ is assumed to be small, in addition to the assumptions mentioned above. (auth)

39420 D-WAVE QUARK–QUARK FORCES AND BARYON MULTIPLETS. Katyal, D. L. (National Physical Lab., New Delhi. Univ. of Delhi). Nuovo Cim., 56A: 382-90(July 21, 1968).

The energy spectrum of baryons and their resonances is examined in detail using para-statistics and d-wave quark-quark forces within the three-quark model. The model is an extension of the one proposed earlier by Mitra. The main results are: i) a realization of 56 states of $L^P = 0^+$, 2^+ and 4^+ along with 70 states of $L^P = 1^+$ and 3^+; ii) the 56 reps. of $L^P = 1^-$ and 3^- and 70 rep. of $L^P = 2^-$; iii) one gets an energy formula of the type $E_L = \bar{E}$–const η_L for the central mass of a given L^P multiplet, where $\bar{E}$ is the ionization energy of the quark-diquark system, and is appreciably higher than the corresponding limit with s-wave forces. (auth)

39421 SECONDARY CONTRIBUTIONS TO THE FORWARD πp CHARGE-EXCHANGE AMPLITUDE. Beaupre, J. V. (Ames Lab., Iowa). Nuovo Cim., 56A: 547-50(July 21, 1968).

A search was made for secondary contributions to the forward πp charge exchange amplitude using total cross-section data, sum rules, and the sum-rule consistency condition. Three models are considered; the ρ' Regge-pole contribution, a Regge dipole, and a Regge cut. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 39262, 39264, 39324, 39377, 39403, 39406, and 39497.

39422 (COO–1112-154) POSSIBLE REASONS FOR A GAUSSIAN INTERACTION PROBABILITY DENSITY IN HIGH ENERGY COLLISIONS. Krisch, A. D.; Krisch, J. P. (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1966]. Contract AT(11-1)-1112. 6p. (CONF-670934–12). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

A possible basis for the assumption of a Gaussian interaction probability density is suggested for a previously proposed model for strong interactions. The basic assumption of this model is that the source function or interaction probability density for meson production in a two-body collision is a Gaussian in the distance between the two incoming particles. It is proposed that the Gaussian dependence is due to the central limit theorem of statistics. The inelastic scattering of two particles, such as protons, is considered. (J.F.P.)

39423 (ITEF-542) K VOPROSU O πd-RASSEYANII. (Regarding the Question of πd Scattering). Dal'karov, O. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institute Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 11p. (In Russian). Dep.

For an initial π-meson kinetic energy T = 200 MeV, the contribution of square diagram with the virtual isobar Δ_{33}, into the πd-elastic scattering is calculated. Sufficient agreement of experimental and theoretical curves is obtained. (auth)

39424 (JINR-P1-3881) METHODS OF SEPARATION OF NUCLEAR REACTION CHANNELS WHILE BOMBARDING THE BUBBLE CHAMBER WITH 2 TO 10 GeV NEUTRONS. Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 12p. (In Russian). Dep.

The methods of separation of the reaction channels of the np-interactions in three- and five-prong stars, produced while bombarding a 24-litre bubble chamber with the 2- 10 GeV neutron beam, were considered. The separation is based on the χ^2 method and on the investigation of extreme kinematics using some considerations of the probability of realization of the effective masses of secondary particles. As a result, a sufficiently good separation of the reaction channels is achieved. The methods considered allow the most probable momentum of the neutron, which induced this interaction, to be estimated. (auth)

39425 (JINR-P2-3803) OB AMPLITUDE TORMOZNOGO IZLUCHENIYA PRI SOUDARENII NUKLONOV. (On the Bremsstrahlung Amplitude by Nucleon Collisions). Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 19p. (In Russian). Dep.

The general form of the nucleon-nucleon bremsstrahlung (NNB) amplitude was determined. Restrictions on scalar amplitudes resulting from parity conservation are discussed. In the Low approximation NNB amplitudes are expressed in terms of NN-scattering amplitudes. (auth)

39426 (JINR-P2-3830) BREMSSTRAHLUNG BY NUCLEON COLLISIONS IN THE LOW APPROXIMATION. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 17p. (In Russian). Dep.

The observed values of the process $NN \to NN\gamma$(NNB) are expressed in the Low approximation by the values of elastic NN-scattering. It is shown that the components of any polarization tensor in the NNB are expressed only in terms of the components of analogous polarization tensor in the NN-scattering and their derivatives. Imitation of the T-noninvariant effects in the NN-scattering by the bremsstrahlung is discussed. (auth)

39427 STATISTICAL MODEL OF HIGH ENERGY JET SHOWERS. Yoneyama, Tohru (Shizuoka Univ., Japan). Rep. Fac. Sci., Shizuoka Univ., 2: 25-30(Dec. 1967).

High energy jets in the cosmic ray energy region can be explained well by a model. This model is interpreted with stresses from statistical mechanical view point. Recent multiple pion production in nuclear emulsions exposed at an accelerator is analyzed and some information is obtained. The picture already used is applied to this lower energy range phenomena, and it can explain well the known data. The applicability of the picture to the jet phenomena is discussed. (auth)

39428 ELECTRIC FORM FACTORS OF ^{3}H AND ^{3}He AND INTERACTION BETWEEN NUCLEONS. Kalade, Yu. A. (Vilnus State Univ., USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst Mokyklos, 8: 279-84(1967). (In Russian).

The relation between the form of the radial wave functions in the coordinates given previously (Kalade, et al., Trud AN Lit. SSR, Ser B 1(23), 13(1963)) and the form of the interaction potential was examined. The electric form factors, the nuclear radii, and the binding energy of ^{3}H, ^{3}He, and ^{4}He were calculated. The calculation results were compared with the experimental values. (tr-auth)

39429 PARTICLE PRODUCTION IN NUCLEI AND UNSTABLE PARTICLE CROSS SECTIONS. Koelbig, K. S.; Margolis, B. (CERN, Geneva). Nucl. Phys., B6: 85-101(1968).

A theory is presented of coherent and incoherent production of particles in medium and heavy nuclei at very high energies where threshold effects are negligible. The modification necessary for coherent production at lower energies (of the order of a few GeV or less) is made. Both coherent and incoherent production are sensitive to the total cross section for the produced particle on the nucleon. Tables are given of the "effective nucleon numbers" involved in production. These are useful in the determination of the cross section of the produced particle on a nucleon. This study offers the possibility for determining the cross sections of virtually all unstable particles or resonances. Detailed angular distribution calculations are presented for the case of photoproduction of ρ^0 mesons. A determination of the ρ^0-nucleon total cross section is made by comparison with existing data. (auth)

39430 PION THEORY OF RELATIVISTIC NUCLEON–NUCLEON INTERACTION. Kaskas, James. Detroit, Wayne State Univ., 1964. 84p.

Thesis.

The exact fourth-order correction to the one-pion exchange interaction and the exact two-pion exchange interaction are calculated for elastic nucleon-nucleon scattering in the energy range up to 310 MeV using the pseudoscalar pion theory with pseudoscalar coupling and assuming the charge independence of nucleon-nucleon interaction. It is found that the fourth-order correction to the one-pion exchange interaction is small, but not negligible, especially at 310 MeV and for larger scattering angles. The two-pion exchange interaction is found to contain appreciable relativistic effects. In particular, the two-pion exchange interaction is shown to produce the major contribution to the spin-orbit interaction at 310 MeV. This result is contrary to the results of all previous approximate calculations which predict a negligible two-pion exchange spin-orbit interaction. (Diss. Abstr.)

39431 MESON RESONANCES AND NUCLEAR FORCES. Haracz, Richard Daniel. Detroit, Wayne State Univ., 1964. 98p.

Thesis.

The problem of nuclear forces can be treated by a combination of the field-theoretical interaction and a phenomenological core, and the major contribution to the interaction outside the core is derived from the exchange of one- and two-pions and the meson resonances. An accurate determination of the effect of the meson resonances was carried out giving special attention to the η resonance which completes the octet of well-known pseudoscalar mesons. Thus, the exact secord-order-contributions to the nucleon-nucleon interaction were obtained from the σ scalar, η pseudoscalar, and ω and ρ vector meson resonances, and an effect never before evaluated—the contribution from the exchange of a pion and an η meson was included. These results show, first, that a relativistic treatment of the meson resonances is necessary for nucleon-nucleon scattering energies greater than 95 MeV. Moreover, the $\pi + \eta$ contribution is shown to provide a significant correction to the second-order resonance effects. It is believed, therefore, that the results when added to the one- and two-pion exchange contributions and applied to nucleon-nucleon scattering data should provide further insights into the nature of nuclear forces outside the core, and allow one to derive valuable information about the coupling constants for the meson resonances. (Diss. Abstr.)

39432 THEORY OF THE THREE-NUCLEON SYSTEM. Fuda, Michael George. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 104p.

Thesis.

The theory of the tri-nucleon (^{3}H and ^{3}He) was rounded out and completed. Starting from an idea of Lovelace, the use of the unitary pole approximation (U.P.A.) to the two-body t-matrix was justified in the instance that the tensor force is taken into account. It was shown, by considering a specific example, that one can expect the unitary pole approximation to a t-matrix to match that t-matrix on the energy shell up to medium energies (~80 MeV); and further that the use of the U.P.A. leads to three-body binding energies which differ by a small amount from those obtained using the full t-matrix. By introducing the elements of the permutation group, S_3, into the Faddeev equations, the handling of these equations was simplified. Taking advantage of this simplification, the correct equations were derived for the trinucleon in the unitary pole approximation. Most importantly, a t-matrix perturbation theory which enables one to find the shift in the three-body binding energy produced by that part of the t-matrix which is neglected in the unitary pole approximation was derived. Finally, a sensible and efficient numerical method was derived for solving the integral equations which arise in the unitary pole approximation. (Disser. Abstr.)

39433 CHAIRMAN'S REMARKS: NUCLEAR PHYSICS IMPLICATIONS OF THE SPIN 2 MULTIPLET. Ne'eman, Yuval (Tel-Aviv Univ., Israel). pp 149-51 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

The nuclear structure of the deuteron is considered. A hard core due to vector mesons is described, and possible experimentally observable effects due to the 5e vector mesons are considered. This problem is briefly presented but not resolved. (J.F.P.)

39434 NEW RESULTS ON PHASE-SHIFT ANALYSIS OF THE NUCLEON–NUCLEON SCATTERING AT THE ENERGY 630 MeV. Glonti, L. N.; Kazarinov, Yu. M.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 1060-8(May 1968). (In Russian).

A phase-shift analysis of the data on the nucleon-nucleon scattering at the energies near 630 MeV is performed. Assuming the validity of the one-meson approximation starting from the angular momentum $l = 6$, five solutions with $\chi^2 \leq 1.5\chi^2_{min}$ are obtained. Using a criterion more strict than the χ^2 criterion, one can show that the maximal probabilities for making an error of the first kind throwing away the solutions 1, 4, and 5, are $<5 \cdot 10^{-4}$, $<5 \cdot 10^{-4}$ and 4.6%, respectively. Thus, in addition to the solution known before, one has a new set of phase shifts, essentially different from the known one in most of the phase shifts. This additional set with low χ^2 appears when the meson production from the non-resonant $^3F_4$ state is taken into account. Imaginary corrections to the phase shifts of the waves with zero isospin do not improve description of the data and do not exceed the errors. (auth)

39435 ON THE BINDING ENERGIES OF THE $^6He_\Lambda - {}^6Li_\Lambda$ ISO-DOUBLET. Gibson, B. F.; Goldberg, A.; Weiss, M. S. (Univ. of California, Livermore). Nuovo Cim., 56B: 190-1(July 11, 1968).

Previously reported results for the binding energies of s-shell hypernuclei using a Hartree–Fock approximation are extended to the p-shell hypernuclei Λ-^{6}He and Λ-^{6}Li in order to examine the exchange nature of the Λ-N interaction and the existence of Λ-^{6}Li. Using previously determined two-body potentials it is concluded that the Λ–N interaction is predominantly 2π exchange and that the hypernucleus Λ-^{6}Li should be unstable with respect to decay into a proton plus Λ-^{5}He. (J.F.P.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 39310, 39476, 39492, 39584, and 39610.

39436 (AD-664307) A GENERAL STUDY OF THE WIGNER COEFFICIENTS OF SU(1,1). Holman III, Wayne J.; Biedenharn, Lawrence C. Jr. (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies. Duke Univ., Durham, N. C. Dept. of Physics). 1968. 34p. CFSTI.

The Wigner coefficients which couple any two irreducible unitary representations of the noncompact group SU(1,1) are derived by means of the second-order difference equation which defines them. It is found that whenever at least one of the three representations being coupled is discrete, then the two solutions are degenerate, but two linearly independent nontrivial solutions exist, in general, when all three representations are continuous. For this case two orthonormal solutions are found. Some elementary symmetries of the solutions are examined. The integral over the group manifold is regularized by means of a convergence factor in order to make all the irreducible unitary representation functions (the Bargmann functions) mutually orthonormal. This regularization is used for the investigation of the resolvent of the Laplace-Beltrami operator in the space of the Bargmann functions. (auth) (USGRDR)

39437 APPLIED GROUP THEORY. Cracknell, Arthur P. Selected Readings in Physics. New York, Pergamon Press, Inc., 1962. 426p. $7.50H, $6.00F.

Part 1 begins with a brief discussion of symmetry and the theory of groups. Other topics include crystallographic groups; the rotation, symmetric, and Lorentz groups; vibrations in molecules and solids; electronic states in atoms, molecules and solids; and atoms, nuclei, and elementary particles. Part 2 contains reprints of published papers on various topics in applied group theory. (L.B.S.)

39438 CONFORMAL GROUP AND CAUSALITY. Rosen, Joe (Brown Univ., Providence). Contract AT(30-1)-2262. Ann. Phys. (N. Y), 47: 468-80(May 1968). (NYO-2262TA-161).

Space-time transformations in Minkowski space are interpreted as neither "active" nor "passive" but as transformations of events and trajectories of processes with respect to the same observer and in the same flat space-time. The distinction is significant for the nonlinear special conformal transformations, which violate causality in the sense that the causal relations among events of a process are not always the same as among corresponding events of a transformed process. A special conformal transformation can always be found to transform the separation of any pair of events of nonlightlike separation from timelike to spacelike and vice versa. The transformation of trajectories under special conformal transformations is studied. Examples of reversal of temporal ordering by special conformal transformations are presented. Finally it is argued that non of this should prevent the conformal group from being physically useful. (auth)

39439 KINEMATICS AT INFINITE MOMENTUM. Bacry, H. (Inst. for Advanced Study, Princeton, N. J.); Chang, N. P. Ann. Phys. (N. Y.), 47: 407-23(May 1968).

A contraction is performed on the Poincaré group which leads to a group isomorphic to the Poincaré group. By "contracting" the canonical representation of the Poincaré generators, it is shown that this iso-Poincaré group described the kinematics of a system of particles all with $\nu_z = 1$. The behavior of the p_z infinite states under finite iso-Poincaré transformations is explicitly given. The corresponding transformation laws under parity and time reversal are also given. As an application, a scattering process as viewed by an observer moving with $\nu_z = -1$ is studied. This leads to a very natural justification of the impact parameter representation of S-matrix element. In conclusion, some indications are given on the covariant generalization of the iso-Poincaré group. (auth)

39440 SYMMETRY PRINCIPLES AT HIGH ENERGY. Fifth Coral Gables Conference, January 24-26, 1968. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968. 390p. $15.00. (CONF-680110).

The conference included 19 papers, three of which were abstracted previously in NSA. For abstracts of these papers see abstract numbers: 22: 20308, 22: 22432, and 22: 26725. Separate abstracts were prepared for 16 papers. (J.F.P.)

For abstracts of individual papers see: 39245, 39308, 39310, 39311, 39338, 39339, 39384, 39387, 39433, 39441, 39445-39447, 39461, 39462, and 39497.

39441 WAVE EQUATION FOR ALL SPINS AND LEPTONIC MULTIPLETS. Kursunoglu, Behram (Univ. of Miami, Coral Gables, Fla.). pp 87-104 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

An example of a wave equation which can describe any spin is discussed. The equation contains the generators of the group SU(3,1) and SL(2,C), and it yields mass spectra for leptons and hadrons. The spectra depend on three arbitrary parameters and also on the Lorentz invariant quantum numbers arising from the solving of quadratic, cubic, quartic, etc., equations for the quantity $\eta = p/mc$, where $p = (p_1^2 - p^2)$. Maxwell's equations are used in the derivation of this wave equation. (J.F.P.)

39442 PROPERTIES OF THE EXCEPTIONAL G_2-LIE GROUP. McConnell, James (St. Patrick's Coll., Maynooth, Ireland). Proc. Roy. Irish Acad., Sect. A, 66: 79-92(Mar. 1968).

The weight diagrams and basis vectors for lower-dimensional representations of the G_2-group are studied. The irreducible 21-dimensional representation of GL(7) is reduced for G_2 into the fundamental 7- and the regular 14-dimensional representation, and the irreducible 28-dimensional representation of GL(7) is reduced into a 27- and a one-dimensional representation of G_2. Bilinear, trilinear and quadrilinear invariants for G_2 are constructed. (auth)

39443 ALGEBRAS IN HADRON PHYSICS. Ne'eman, Yuval (Tel-Aviv Univ., Israel). pp 273-325 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

The discussion of algebras in hadron physics covers the development of current algebra including SU(3) symmetry, its physical applications, current-generated algebras, SU(6) structures and superconvergence, and the dynamical high-energy algebra U(3) × U(3). It is found that there exist the foundations for an exact algebraic theory of the strong interactions. The densities of the scalar and vector high-energy currents are connected with the usual weak and electromagnetic vector currents and with the gravitational current. However, these densities differ mainly in that they represent couplings to the 1^- or 2^+ poles of the non-strong form factors. (J.F.P.)

39444 EXACT RELATIVISTIC SU(6). White, Roscoe (Univ. of California, Los Angeles). pp 449-70 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

The general features of a theory are examined in which a difficulty in SU(6), that vertices do not exist, is exactly solved, and another difficulty of SU(6), that the mass breaking within SU(6) multiplets is fairly large, is completely ignored. This immediately leads to the additional complication of the static symmetry algebra containing an infinite number of particles. However, the very presence of these states leads to many unexpected and extremely physical features in the theory. The structure of the symmetry algebra, SL(6,C) subgroups and representations, and physical properties of the invariants are covered. (J.F.P.)

39445 NEW WAYS IN SYMMETRY AND DYNAMICS. Cabibbo, Nicola (Univ., Rome). pp 339-54 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

Chiral symmetry, phenomenological Lagrangians, and the recent developments on space-time symmetries in connection with Regge poles are reviewed. Also the quark model and its perspectives and the possible physical evidence in favor of the Han-Nambu model are described, coming from the existence of S = +1 baryonic resonances. CP violation in weak interactions, bootstraps and broken symmetry, problems of stability, and Regge poles and current algebra are discussed. (J.F.P.)

39446 NONLINEAR CHIRAL DYNAMICS. Zumino, Bruno (New York Univ., N. Y.). pp 235-60 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

Some general points of nonlinear chiral dynamics and some aspects of the use of chiral SU(3) × SU(3) are considered. Nonlinear realizations, the construction of invariant Lagrangians, and symmetry breaking, are treated. (J.F.P.)

39447 THE STABILITY OF REPRESENTATIONS OF THE POINCARE GROUP. Wightman, A. S. (Princeton Univ., N. J.). pp 291-314 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

Certain elementary questions arising in the phenomenological description of particles of arbitrary (finite) spin are discussed. Examples of unstable and stable representations of spin-$^3/_2$ are treated. It is established using these examples that the notion of stability of representations of the Poincaré group is a valid one. (J.F.P.)

39448 APPLICATION OF GROUP THEORY IN PHYSICS. Lyubarskii, G. Ya. New York, Pergamon Press, Inc., 1960. 389p. $10.00; 63s.

Translated from the Russian by Stevan Dedijer.

A detailed treatment is given of those parts of the theory of representations of finite and continuous groups that are most important in application to theoretical physics. Some of the topics covered include: small oscillations of symmetrical systems; second order phase transitions; crystals; the Schroedinger equation; absorption and Raman scattering of light; relativistic invariant equations; and nuclear-reactions. Tables are given in the appendices for the detailed description of the 230 space groups and for the characters of certain groups, together with a considerable number of problems. (L.B.S.)

39449 CALCULATION FORMULAS AND GRAPHIC TECHNIQUE FOR THE CLEBSCH-GORDAN COEFFICIENTS OF SU(n) GROUPS. Karasev, V. P.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 1131-46(May 1968). (In Russian).

A general method is presented for evaluating the Clebsch-Gordon coefficients (with normalization) as well as their combinations for any SU(n) group. The graphic and the algebraic calculation techniques are developed. The SU(3) group is considered in detail, and necessary formulas are given for SU(3).

Like the elaborate theory of angular momenta this approach makes it possible to formalize completely calculations with the Clebsch–Gordan coefficients for the SU(n) groups. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 39246 and 39247.

39450 (JINR–E2-3801) ELECTRIC DIPOLE MOMENT OF SPINOR PARTICLES AND ELECTROMAGNETIC CP-VIOLATION. Filippov, A. T.; Oziewicz, Z.; Pikulski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 10p. Dep.

It is shown that there exists the possibility of construction of the CP-noninvariant P-conserving electromagnetic interaction in such a way that the neutron electric dipole moment is of the order 10^{-23} e.cm which does not contradict the recent experimental data. (auth)

39451 η_+ PHASE, Re ϵ, AND THE SUPERWEAK MODEL. Bennett, S. (Columbia Univ., New York); Nygren, D.; Saal, H.; Sunderland, J.; Steinberger, J. Phys. Lett., 27B: 248-9(July 8, 1968).

The determination of the regeneration phase and of the $\Delta S - \Delta Q$ violating parameter together with previous experiments yield new values for the η_+ phase and Re ϵ. These are in substantial agreement with the predictions of the superweak model. (auth)

39452 EFFECTS OF $\Delta S = -\Delta Q$ ON CP-NONCONSERVATION PHENOMENOLOGY IN K^0 DECAY. Buchanan, C. D.; Lande, K. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 21: 169-72(July 15, 1968).

Incorporating the present experimental value of the $\Delta S = -\Delta Q$ amplitude into the K^0 CP-nonconservation phenomenology, it is found that solution II (η_{00} and η_+ in opposite quadrants) is as viable as solution I (η_{00} and η_+ in the same quadrant), though both have poor fits. Thus, if a $\Delta S = -\Delta Q$ amplitude is allowed, a clear choice between these two solutions cannot yet be made. (auth)

39453 CHIRAL SYMMETRY AND THE PION MASS. Kantor, P. B.; Pietenpol, J. L. (Case Western Reserve Univ., Cleveland). Phys. Rev. Lett., 21: 241-2(July 22, 1968).

The realization of chiral SU(2) ⊗ SU(2) symmetry by nonlinear field transformations is considered from the standpoint of axiomatic field theory. It is shown that the communication relations of chiral symmetry are incompatible with the assumption that the pion has nonzero mass. (auth)

39454 CHIRAL SYMMETRY BREAKING IN K_{l3} DECAYS. Chang, Lay Nam (Massachusetts Inst. of Tech., Cambridge); Leung, Y. C. Phys. Rev. Lett., 21: 122-5(July 8, 1968).

A current-algebra calculation of the K_{l3} form factors is made under the assumption that the chiral SU(3) symmetry is broken by an interaction which transforms under the representation $(\underline{3},\underline{3}^*) \oplus (\underline{3}^*,\underline{3})$. Quantitative results on the weak decay parameters of the mesons, the κ-meson mass, and the form factors $f_+(0)$ are obtained. The factor ξ is found to be very nearly zero. (auth)

39455 $\Delta S = \Delta Q$ RULE IN THE DECAY $K^0 \to e^+ + \nu + \pi$. Bennett, S. (Columbia Univ., New York); Nygren, D.; Saal, H.; Sunderland, J.; Steinberger, J.; Kleinknecht, K. Phys. Lett., 27B: 244-7(July 8, 1968).

The magnitude of the charge asymmetry in K_{e3} decay following a regenerator is analysed with the help of auxiliary experiments which determine the magnitude of the regeneration amplitude. It is found that $(1 - |x|^2)/|1 + x|^2 = (1.06 \pm 0.06)$, where x is the $\Delta S - \Delta Q$ violating amplitude relative to the $\Delta S = \Delta Q$ conserving amplitude. The test is more sensitive than previous tests of $\Delta S - \Delta Q$ conservation, and in agreement with no violation. (auth)

Applications (Strong)

39456 (IC–68/43) MESON-BARYON AND BARYON–BARYON SCATTERING IN REGGEIZED U(6) x U(6) THEORY. Delbourgo, R.; Rashid, Harun-Ar (International Centre for Theoretical Physics, Trieste (Italy)). June 1968. 21p. Dep.

A complete set of rules is presented for evaluating the master meson trajector exchange contribution to high-energy scattering between mesons (M) and baryons (B) in U(6) ⊗ U(6) theory. The practical implementation of these rules is illustrated in considerable detail for quark-quark scattering as well as for $\underline{35}$W exchange to MB and BB charge exchange amplitudes. (auth)

39457 (ITF–68-12) DECAYS OF 2^+ MESONS AND SU(6) SYMMETRY. Kukhtin, V. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 8p. Dep.

The decay $2^+ \to 0^- + 0^-$ is considered for the 189 and 405, representations of the group SU(6) on the basis of SU(3) symmetry. The conclusion is drawn that the particles f, f', K**, A_2 may be assigned to the 405 only. (auth)

39458 DYNAMICAL MODELS AND SYMMETRY GROUPS IN PARTICLE PHYSICS. Musto, Renato. Syracuse, N. Y., Syracuse Univ., 1967. 119p.

Thesis.

It is shown how it is possible to motivate the existence of an underlying algebraic structure in a system of strongly interacting particles, by imposing very general dynamical requirements. Models taken from potential theory and particle physics are analyzed in order to introduce two different kinds of groups useful in the description of such systems, namely "invariance groups" and "noninvariance groups." In particular an expression is given for the generators of the "noninvariance group" for the nonrelativistic hydrogen atom for the quantum mechanical case. Then the problem of the self-interaction of n vector mesons — with particular reference to the physically interesting case n = 8 is discussed, and it is shown how to derive the existence of an invariance group on the basis of bootstrap of self-consistency requirements. In particular some rather unphysical assumptions used in the previous derivations can be eliminated. A quite well known technique is used for obtaining sum rules on the imaginary part of a scattering amplitude, once the energy behavior of this amplitude has been given in a Regge pole model. Such technique is first applied to the pion photoproduction on nucleons and three "superconvergence sum rules" are derived. Such sum rules are saturated with a few intermediate states and the results are compared with experiment. Then the same technique is applied to the pion-isobar interaction in order to derive a "noninvariance group" and the group obtained is compared with the ones that were already proposed for such a system. Finally the technique used is compared with the bootstrap condition in order to obtain the "invariance group" for the vector mesons self-interaction. (Disser. Abstr.)

39459 REPRESENTATIONS OF SOME NONCOMPACT GROUPS AND APPLICATIONS OF NONINVARIANCE GROUPS TO PARTICLE PHYSICS. Kuriyan, Jacob George. Syracuse, N. Y., Syracuse Univ., 1967. 60p.

Thesis.

A method is discussed which is called the method of master analytic representation, of obtaining the Hermitian representations of the Lie algebra of certain noncompact groups by considering the representations of related compact groups. To illustrate the method, the representations of the groups O(2,1), O(3,1), and O(4,1) are obtained from those of O(3), O(4), and O(5), respectively, and the degenerate representations of SL(3,R) and SL(4,R) from those of SU(3) and SU(4), respectively. The method generalizes easily for groups such as O(p,1), SU(p,1), and SL(p,r). To handle groups such as O(p,q), ($p \neq 1, q \neq 1$) using this method, it is necessary to reduce O(p,q) with respect to O(p,q-1). A modest beginning is made in this direction by reducing the continuous representations of O(2,1) with respect to O(1,1). In the entire approach only the well-known infinitesimal operator techniques of angular momentum are used and the claim is that this method can be used to study a wide class of problems where noncompact groups are used. A few such examples are given. The possibility of using noninvariance groups to study properties of strongly interacting particles are considered. The static results (magnetic moments, coupling constant etc.) of the conventional SU(4) and SU(6) invariant theories are rederived under much less restrictive conditions. Meson baryon scattering is considered and the Johnson Trieman relationship rederived under more general conditions of validity. The differences between this formulation and the conventional SU(6) theory are stated. Wherever possible, predictions of the theory are compared with experimental data. (Disser. Abstr.)

39460 BROKEN $SU_W(6)$ SYMMETRY AND THE NINTH PSEUDOSCALAR MESON. Zaslavskii, A. N.; Ogievetskii, V. I.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 33: 209-16(Feb. 1968). (In Russian).

The possible broken $SU_W(6)$ symmetry was considered using as an example the mass formula. The results obtained were the same for baryons as in the case of static groups of SU(6). The known difference in the classification of mesons with W spins and ordinary spins in $SU_W(6)$ suggests that with all broken symmetries the ninth pseudoscalar meson must have mass of approximately 1.40 GeV. If the mass value E(1420) is very close to actuality, the most probable value of its spin–parity would equal 0^-. The results obtained are accurate in the $SU_X(6)$ group which generalizes $SU_W(6)$ to the case of any binary reaction. (tr-auth)

39461 THE 0(3,1) EXPANSION OF THE FORWARD SCATTERING AMPLITUDE AND THE ZEROS OF THE REGGE RESIDUES. Toller, Marco (CERN, Geneva). pp 115–48 of Sym-

metry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

The peculiar behavior of the Regge residues at the points where the complex angular momentum is integral or half integral is studied for the equal-mass case. It is found that the origin of this behavior is that sometimes the representations of 0(2,1) which describe the Regge poles become reducible. In other cases the special behavior is due to the poles and zeros of the weight function which appears in the Plancherel measure for the group 0(2,1). The case is considered in which both these difficulties are present and connected with each other. This happens when a Regge trajectory crosses the axis t = 0 near an integral or half-integral value of the complex angular momentum. A formalism is built which permits a general treatment of these problems. Examples of the rho and pion trajectories are discussed. (J.F.P.)

39462 ON THE DYNAMICAL BREAKING OF SU(3). Michel, Louis (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France); Radicati, L. A. pp 19-48 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

A study is made of what information about the properties of the SU(3) symmetry breaking interaction can be obtained from the geometrical structure of the internal space E_8 of the hadrons. It was found that invariant functions on E_8 like the S-matrix or the Lagrangian are minima or maxima on the charge orbits; if the S-matrix depends upon two vectors, an extremum of S is obtained when the two vectors are two commuting charges; and the value of the Cabibbo angle cannot be found from the solution of a variational principle, at least if restriction is made to first order effects in the electromagnetic and weak interactions. (J.F.P.)

39463 CONNECTION BETWEEN SUPERCONVERGENCE AND ALGEBRA IN GOEBEL'S STATIC MODEL. Bishari, M.; Schwimmer, A. Y. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B6: 149-54(1968).

A superconvergent behavior for the amplitudes in Goebel's static model is assumed. The infinite set of superconvergence equations is solved and the results are shown to be equivalent to those obtained using the $[SU(2)_I \otimes SU(2)_J] \times T_3$ algebra. This gives an example of a complete saturation of an infinite set of superconvergence sum rules, by one-particle states belonging to a representation of a non compact algebra. (auth)

39464 O(4) SYMMETRY AND REGGE POLE THEORY. Wang, Jiunn-ming. Berkeley, Calif., Univ. of California, 1967. 53p. Thesis.

For reactions in which the initial and final states in the t-channel contain equal mass particles (e.g., $N\bar{N} \to \pi\pi$) of masses m and m', it is shown using analytic continuation and Lorentz invariance that the one-mass shell helicity amplitudes in the region t = 0, $(m - m')^2 \le s \le (m + m')^2$, are invariant under the group O(4). Decompositions of the amplitudes in irreducible representations of O(4) (four dimensional partial wave expansions) are obtained and related to conventional partial wave expansions. Poles classified according to the O(4) group are shown to lead to infinite families of Regge poles. The formalism is developed for arbitrary spins and the case of nucleon-nucleon scattering is studied in detail. Results for the Regge pole structure in NN scattering are stronger than those of the conspirator theory. (Diss. Abstr.)

Field Theories

Quantum Field Theory

Refer also to abstracts 38751, 38752, 39232, 39339, 39368, 39491, and 39497.

39465 (ITF-67-53) LEKTSII PO KVAZIKLASSIKE. (Lectures in Quasiclassics). Ponomarev, L. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 79p. (In Russian). Dep.

On the basis of the Zwaan method which was previously developed and using a Kemble's idea, typical problems of the Wentzel–Kramers–Brillouin method are discussed in detail and several new problems of the quasiclassics are solved. Special attention is paid to the method by which quantum mechanical equations should be reduced to the quasiclassical form. Some practical prescriptions are formulated for applying the WKB method. (auth)

39466 (JINR-E2-3831) REPRESENTATIONS OF THE CANONICAL (ANTI) COMMUTATION RELATIONS IN INFINITE TENSOR-PRODUCT SPACE. Sushko, N. V.; Zavialov, O. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 29p. Dep.

A necessary and sufficient condition that a representation of the canonical (anti) commutation relations is unitary equivalent to a direct product representation in von Neumann incomplete tensor-product space is derived as well as a necessary and sufficient condition for unitary equivalence of any two direct-product representations. A characterization of all direct-product representations is given in terms of quasi-invariant product-measures. Given a direct-product representation, the corresponding measure is evaluated explicitly. An immediate consequence of these theorems is a necessary and sufficient condition for equivalence of quasi-invariant product-measures. Special classes of canonical transformations are discussed. (auth)

39467 (MATSCIENCE-59) LECTURES ON RELATIVISTIC PHYSICS IN ONE SPACE AND ONE TIME DIMENSION. Dubin, Daniel A. (Institute of Mathematical Sciences, Madras (India)). [1967]. 32p. Dep. $1.00.

Certain aspects of two-dimensional physics are studied. The fairly trivial Lorentz and Poincaré groups are covered, and then the relevant free fields are classified in terms of scalar fields. Also models are considered. (J.F.P.)

39468 VACUUM POLARIZATION IN THE LEE AND YANG THEORY OF CHARGED SPIN ONE. Cohen, H. A. (Univ. of Adelaide). Nuovo Cim., 56A: 467-78(July 21, 1968).

The radiative correction, to order e^2, to the photon propagator in the Lee and Yang theory of charged spin-one bosons, is calculated in a dispersion-theoretic manner. Some general aspects of the ξ-limiting formalism are discussed. A useful matrix treatment of Lorentz tensors is also presented. (auth)

39469 CONNECTION BETWEEN SINGULARITIES OF THE MATRIX ELEMENTS OF NONRELATIVISTIC QUANTUM FIELDS AND THE PHYSICAL S-MATRIX. Shirokov, Yu. M. (Stekloff Mathematical Inst., Moscow). Nucl. Phys., B6: 159-73(1968).

A method is developed for obtaining connections between residues at the poles and jumps through the cuts of the field matrix elements with the S-matrix on the mass shell. The method is demonstrated on the kinematical and anomalous cuts in the non-relativistic approximation. (auth)

39470 APPARENT WEAKENING OF THE LOCALITY CONDITION. II. Borchers, H.-J. (Univ., Goettingen, Ger.); Pohlmeyer, K. Commun. Math. Phys., 8: 269-81(1968). (In German).

If for a relativistic field theory the expectation values of the commutator $(\Psi|[A(x), A(y)]|\Psi)$ vanish in space-like direction like $\exp\{-\text{const}|(x-y)^2|^{\alpha/4}\}$ with $\alpha > 1$ for sufficiently many vectors Ψ, it follows that A(x) is a local field. Conditions are given for replacing the locality axiom for a hermitean, scalar, tempered field A(x). (TSS)

39471 EQUAL-TIME COMMUTATION RELATIONS OF RENORMALIZED CURRENTS IN PERTURBATION THEORY. I. Schroer, B. (Univ. of Pittsburgh); Stichel, P. Contract AT(30-1)-3829. Commun. Math. Phys., 8: 327-37(1968). (NYO-3829-11).

Equal-time current commutation relations are considered in renormalizable field theories. Renormalized currents are obtained by means of solutions of the Yang-Feldman equations for Heisenberg field operators in perturbation theory. For the computation of matrix elements of current commutators Jost-Lehmann-Dyson type techniques are applied. The equal-time limit is taken with the help of symmetrical time-smearing functions which interpolate the δ-function. The methods avoid any cut-off procedure and lead therefore to unambiguous results. In order to avoid spin complications, the general methods are applied to trilinear resp. quadrilinear couplings of isoscalar and isovector spin-0 mesons in first order perturbation theory. It is found that the zero-space components of the current-commutator matrix elements behave for small time separation T like in (T) $\text{grad}_x \delta(x - y)$. (auth)

39472 PRECISION MEASUREMENTS FOR TESTING OF THE SPECIAL RELATIVITY THEORY. Schmidt-Ott, W.-D. Phys. Bl., 24: 150-8(Apr. 1968). (In German).

Four precision measurements for testing of the special relativity theory are summarized. These are a new Michelson experiment with the Moessbauer effect, testing of the light velocity constant in moving radiation sources, measurements of time expansions in fast mesons, and precision measurements of the velocity dependence of the mass of the electron at high electron energy. (J.S.R.)

39473 VACUUM STRUCTURE IN QUANTUM ELECTRODYNAMICS. Mitter, H. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Phys. Bl., 24: 159-64(Apr. 1968). (In German).

Studies made on the vacuum structure in quantum electrodynamics are reviewed. The Casimir effect is first described. Term displacement, abnormal moment, and scattering of electrons are then discussed. Vacuum polarization is considered. (J.S.R.)

39474 SOME ASPECTS OF TWO-DIMENSIONAL QUANTUM FIELD THEORY. Dubin, Daniel Abrom. New York, New York Univ., 1967. 91p.

Thesis.

The Lorentz and Poincaré groups are discussed as a background for quantum field theory in two dimensional space-time. Then some free fields are investigated. A scalar formulation for the spinor and vector free fields is examined. Next the free massless scalar field, defined with the help of Wightman's regularization at $p = 0$, is considered. The one-particle sector is studied in detail and, when completed, is a Pontriagin space $\pi_1 \oplus \pi_1$. An exactly solvable model of massless spinors interacting with massive vector mesons ($m_0 > 0$) in two dimensions is investigated next. Operator solutions are given constructed out of free fields and depending upon which of two definitions of the current are employed. The freedom of gauge is considered and solutions in some different gauges are indicated. Finally, the limits $m_0 \to \infty$ to the Thirring model and $m_0 \to 0$ to the Schwinger model are discussed. The former limit is obtained in the sense of convergence of distributions in S' whereas for the latter an operator limit is not given but some complications that occur are merely indicated. (Disser. Abstr.)

39475 RECENT DEVELOPMENTS IN QUANTUM ELECTRODYNAMICS. Johnson, Kenneth (Massachusetts Inst. of Tech., Cambridge). pp 3-86 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

Some methods are discussed which can be used to study the properties of the Green functions of electrons and photons asymptotically far off the mass shell of the physical particles. An attempt is made to show that from the ordinary renormalized perturbation solutions of the Dyson–Schwinger equations for Green functions it can be concluded that the bare mass of the electron must be zero. Also it is attempted to state clearly all the additional assumptions that are needed in deriving this result. It is found that the meaning of this fact is that the Lehmann equation for the bare mass expressed in terms of renormalized spectral functions would yield an electron bare mass of zero, and this result would occur as an identity, holding for all values of the physical mass and coupling constant. It is also shown that a similar result holds for the bare charge as long as it is smaller, and the equation which relates them $e^2/Z_3(e^2) = e_0^2$ should in fact hold as an identity in e^2 obeyed as long as $0 < e^2 < e_0^2$. One obtains an equation for the function $f(x)$ which determines e_0^2 as the solution of $f(e_0^2) = 0$. (J.F.P.)

39476 INFINITE COMPONENT FIELD THEORIES. Fronsdal, Christian (Univ. of California, Los Angeles). pp 393-447 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

The discussion of infinite-component field theories covers a review of the basic ideas and successes of SU(6), experimental predictions of SU(6), representations of the Poincaré group, some representations of SO(f,1), partial waves and the relativistic S-matrix, and crossed partial waves in nonrelativistic potential scattering and classical relativistic mechanics. (J.F.P.)

39477 ADDITIVITY OF CONSERVED CHARGE OPERATORS. Leroy, J.-P. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B6: 390-4(1968).

It is shown that in any local field theory the charge associated with a conserved local current is additive. This result allows the charge associated with the ρ-meson field to be related to the isotopic charge operator, as asserted by Kroll, Lee, and Zumino. (auth)

39478 ENERGY PARADOX IN LORENTZ-INVARIANT ELECTRODYNAMICS. Cloetens, W. J. M. (Univ. de El Salvador, San Salvador, Bahama Islands. Univ. Libre, Brussels). Nuovo Cim., 56A: 403-8(July 21, 1968).

It is proved that the well-known Lorentz-invariant or Galileo-invariant equation of motion implies an energy paradox; so we may say that it is not sure that Lorentz-invariant electrodynamics are compatible with energy conservation. (auth)

39479 A SIMPLE AND PRACTICAL METHOD TO DERIVE THE EXPRESSION OF THE COUPLING CONSTANT OF THE YUKAWA THEORY EQUIVALENT TO A FERMI THEORY. Andriambololona, Raoelina (Faculte des Sciences, Marseille). Nuovo Cim., 56A: 257-68(July 21, 1968).

A simple and practical method to obtain the expression of the coupling constant of the Yukawa theory equivalent to a Fermi theory is given. Our method is consistent with the condition that the renormalization constant Z_3 of the composite boson is equal to 0. (auth)

Gravitation and General Relativity

Refer also to abstract 39307.

39480 PROPAGATION OF A PHOTON IN A STATIC FIELD AND IN THE FIELD OF THE SUN ACCORDING TO GENERAL RELATIVITY. Richard, J.-P. (Univ. of Maryland, College Park). Nuovo Cim., 56B: 1-11(July 11, 1968).

A general-relativistic formula of the frequency shift, valid in a static field, is derived according to a method developed by Synge. The result is also given explicitly for the case where the emitter and the receiver are in the field of the sun described by the Schwarzschild field. The calculation is carried up to the third order in (v/c) where c is the speed of light and v the speed of the emitter or of the observer. It is shown that a third-order effect arises from the general-relativistic corrections to the motion of the photon. This effect is of order 10^{-10} to 10^{-9} in the specific cases discussed. The invariance property of the results under general co-ordinate transformations is discussed. (auth)

39481 GRAVITATIONAL INDUCTION FIELD COMMUNICATIONS EXPERIMENT AT 1660 CYCLES PER SECOND. Sinsky, Joel Abram. College Park, Md., Univ. of Maryland, 1967. 134p.

Thesis.

A 1660 cps gravitational induction field communications experiment with massive aluminum cylinders for the generator and receiver is described. The generator was an 8 inch diameter, approximately 5 feet long, cylinder which was suspended by wire in a milled groove about its center in a vacuum chamber. Large two-inch square Ba T_i O_3 piezoelectric crystals bonded to its surface drove the bar in its fundamental longitudinal resonant mode. When a large ac voltage was applied to the crystal (2000 volts peak to peak) at the natural resonant frequency of the high Q cylinder, high dynamic strains (10^{-4}) were produced in the bar. The detector Q was about 2×10^5; thus its response bandwidth was less than 0.01 cycles per second. The frequency of the generator was therefore maintained to within 0.01 cps of the detector's natural resonant frequency. This was accomplished by accurately controlling the temperature of the generator with a heating coil wrapped about its center. The gravitational potential in all space of the generator was calculated by using Newton's theory of gravitation. An important consequence is that the detector for gravitational radiation was tested and proved capable of detecting strains as small as a part in 10^{18}, relative displacements of a hundredth of a nuclear diameter over distances of two meters. This kind of sensitivity is believed capable of detecting events such as the collapse of a supernova core almost anywhere with the galaxy. (TSS)(Diss. Abstr.)

39482 GRAVITATION MASS AND LIGHT DEFLECTION. Nachtmann, Otto; Schmidle, Harald; Sexl, Roman (Univ., Vienna). Acta Phys. Austr., 26: 227-30(1967). (In German).

It is shown that a value of light deflection different from the one predicted by general relativity cannot be explained by a finite graviton mass. (auth)

39483 ICARUS HURTLES PAST. Hindley, Keith (Univ. of Liverpool). New Sci., 38: 580-1(June 13, 1968).

On June 14th, 1968 the half-mile-diameter chunk of rock known as Minor Planet 1566 Icarus will flash past at a distance of some $4\frac{1}{4}$ million miles. Its close approach to the Earth should provide much needed information on the nature of relativity. (auth)

39484 NEW FOUNDATION OF GENERAL RELATIVITY. Guth, Eugene (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 21: 106-9(July 8, 1968).

The essential point is to establish the uniqueness of general relativity by postulating the derivability of the equations of motion from the (gravitational) field equations. It is also emphasized that even with regard to agreement with experiment (including cosmology) there exist, in my opinion, no compelling arguments against general relativity. (auth)

39485 NEW CONSERVATION LAWS FOR ZERO REST-MASS FIELDS IN ASYMPTOTICALLY FLAT SPACE-TIME. Newman, E. T. (Univ. of Pittsburgh); Penrose, R. Proc. Roy. Soc. (London), Ser. A, 305: 175-204(1968).

Some recently discovered exact conservation laws for asymptotically flat gravitational fields are discussed in detail. The

analogous conservation laws for zero rest-mass fields of arbitrary spin s(= 0, ½, 1, ...) in flat or asymptotically flat space-time are also considered and their connexion with a generalization of Kirchoff's integral is pointed out. In flat space-time an infinite hierarchy of such conservation laws exists for each spin value, but these have a somewhat trivial interpretation, describing the asymptotic incoming field (in fact giving the coefficients of a power series expansion of the incoming field). The Maxwell and linearized Einstein theories are analysed in particular. In asymptotically flat space-time only the first set of quantities of the hierarchy remain absolutely conserved. These are 4s + 2 real quantities, for spin s, giving a D(s,0) representation of the Bondi-Metzner-Sachs group. But even for these quantities the simple interpretation in terms of incoming waves no longer holds good; it emerges from a study of the stationary gravitational fields that a contribution to the quantities involving the gravitational multipole structure of the field must also be present. Only the vacuum Einstein theory is analysed in this connexion, the corresponding discussions of the Einstein-Maxwell theory (by Exton and the authors) and the Einstein-Maxwell-neutrino theory (by Exton) being given elsewhere. (A discussion of fields of higher spin in curved space-time along these lines would encounter the familiar difficulties first pointed out by Buchdahl.) One consequence of the discussion given is that a stationary asymptotically flat gravitational field cannot become radiative and then stationary again after a finite time, except possibly if a certain (origin independent) quadratic combination of multipole moments returns to its original value. This indicates the existence of 'tails' to the outgoing waves (or back-scattered field), which destroys the stationary nature of the final field. (auth)

39486 GRAVITATIONAL RADIATION FROM THE SOLAR SYSTEM. Carmeli, Moshe (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Res. Rev. (Office Aerosp. Res.), 7: No. 2, 8-9(Feb. 1968).

The methods of general relativity and Weinberg's S-matrix long-wave formalism are compared and reviewed as they apply to the calculation of gravitational radiation power due to elastic nonrelativistic Coulomb collisions between electrons and protons or electrons in the sun. Both methods yield similar results. (TSS)

39487 GENERAL RELATIVISTIC THEORY OF LAGRANGIAN FUNCTIONS IN THE SPACE X_1. PART II. CLASSIFICATION OF REAL ONE COMPONENT FIELDS. Knapecz, G. (Univ. of Tech. Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 24: No. 1, 97-118(1968).

The basic properties of the Brandt semi-grupoid Bd(1) of general coordinate transformations in the space X_1, the classification of the satellites and objects of Bd(1), and the equivalence problem of the fundamental and some other one-component objects of Bd(1) are treated. It is shown that with the exception of a few objects, the fundamental and some other one-component objects can be expressed by scalars. Therefore the scalars belong to the basic fields in the space X_1. (auth)

39488 RADIATION OF ENERGY BY ARBITRARY AXIALLY-SYMMETRICAL SYSTEM. Dozmorov, I. M. Ivz. Vyssh. Ucheb. Zaved., Fiz., No. 3, 90-3(1968). (In Russian).

The solution obtained by Bondi, Van der Burg, and Metzner for the Einstein field equation for arbitrary axial-symmetrical system was analyzed. The expression for the momentum and energy of the system was found by means of a tetrad system. (tr-auth)

39489 REPLY TO WINTERBERG'S ARTICLE ON THE DETECTABILITY OF GRAVITATIONAL WAVES. Zipoy, D. M. (Univ. of Maryland, College Park); Bertotti, B. Nuovo Cim., 56B: 195-7(July 11, 1968).

The scintillation of starlight was previously discussed as due to the random gravitational fields through which it passed on its way to earth. It was concluded that the effect is measurable and even large in some cases. It is pointed out that (contrary to this assumption) the main first-order effect of the gravitational field on light intensity is identically zero in free space, and the actual effects are second-order and exceedingly small. The remaining first-order effects are due to the usual Doppler shift and are also small. (J.F.P.)

39490 INTERPRETATION OF SOME SPHEROIDAL METRICS. Bonnor, W. B.; Sackfield, A. (Queen Elizabeth Coll., London). Commun. Math. Phys., 8: 338-44(1968).

Zipoy recently studied some static gravitational fields in spheroidal coordinates, and endowed them with unfamiliar topologies. Three of these fields are examined and it is shown that they can also be interpreted as fields in space of Euclidean topology. (auth)

Scattering Theory

Refer also to abstract 39306.

39491 (CERN-68-7(Vol.1), pp 290-315) RIGOROUS THEORETICAL CONSIDERATIONS ON HIGH ENERGY SCATTERING. Epstein, H. (European Organization for Nuclear Research, Geneva (Switzerland)).

The review is restricted to some consequences of the axiomatic field theory, except for the case of lower bounds on scattering amplitudes. The discussion starts with local field theory in the sense of Wightman. It is assumed that there is a unique vacuum and minimum mass greater than zero for all states orthogonal to this vacuum, that each stable particle has an isolated mass hyperboloid and the restriction of the representation of the Poincaré group to the corresponding subspace is irreducible, that each stable particle is represented by at least one local field, that the asymptotic states are complete, and that the generalized retarded functions can be defined as tempered distributions with sharp support properties. (J.F.P.)

39492 (JINR-E2-3841) TWO-DIMENSIONAL EXPANSIONS OF RELATIVISTIC AMPLITUDES, REGGE TRAJECTORIES, AND DAUGHTER POLES. Sheftel, M.; Smorodinsky, J.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 28p. Dep.

The two-dimensional expansions of the relativistic amplitudes for binary scattering processes are discussed with respect to both independent kinematical parameters over the irreducible representations of the O(3,1) group. The connection of these expansions with the Regge pole theory as well as with that of the Toller poles is investigated. The consequences concerning the problem of existence of daughter trajectories are also considered. (auth)

39493 (JINR-P2-3848) RADIATION OF A PARTICLE ON THE ORBIT IN THE $U(r) = -(\alpha/r^2)$ FIELD. Lukach, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 23p. (In Russian). Dep.

The helicity scattering in the classical scattering theory is considered in the case of the $U(r) = -(\alpha/r^2)$ potential. The spectrum of the bremsstrahlung is calculated in the long-wave approximation in the classical and quantum cases for a particle moving in this field. It is shown that in the scattering spectrum of such a particle a series of maxima appears, the number of which in the classical case is equal to the number of particle revolutions around the scattering center, while in the quantum case it is equal to the integral part of the difference of the scattering phases of initial and final states divided by π. (auth)

39494 FAMILIES OF REGGE TRAJECTORIES AT NON-VANISHING ENERGY. I. Domokos, G.; Suranyi, P. (Central Research Inst. for Physics, Budapest). Nuovo Cim., 56A: 445-58(July 21, 1968).

The parent-daughter trajectory phenomenon is studied for spinless particles in the framework of the Bethe-Salpeter (BS) equation. If the kernel of the equation satisfies some natural conditions, the partial-wave amplitude is shown to possess multiple poles in the l-plane, corresponding to a Regge-pole family. Under the same conditions a perturbation formula is given for the derivatives of trajectory functions and residues at zero momentum transfer as a function of $\varkappa$, the order of daughter trajectories. (auth)

39495 QUASIPOTENTIAL TYPE EQUATION FOR THE RELATIVISTIC SCATTERING AMPLITUDE. Kadyshevskii, V. G. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., B6: 125-48(1968). (IC-67/73).

The quasipotential type equation for the relativistic scattering amplitude is obtained with the help of a special kind of perturbation theory. (auth)

39496 S-MATRIX IN CLASSICAL MECHANICS. Hunziker, W. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Commun. Math. Phys., 8: 282-99(1968).

In the Hilbert-space version of classical mechanics, scattering theory for N-particle systems is developed in close analogy to the quantum case. Asymptotic completeness is proved for forces of finite range. Infinite-range forces lead to the problem of stability of bound states and can be dealt with only in some simple cases. (auth)

39497 AXIOMATIC PROOF OF SUPERCONVERGENCE RELATIONS. Mahoux, Gilbert; Martin, Andre (State Univ. of New York, Stony Brook). pp 211-24 of Symmetry Principles at High Energy. Perlmutter, Arnold; Hurst, C. Angas; Kursunoglu, Behram (eds.). New York, W. A. Benjamin, Inc., 1968.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla. See CONF-680110.

The extension to particles with spin is made for the proof that the bound on the forward scattering amplitude for scalar particles, originally derived by Froissart from the Mandelstam representation, is in fact a consequence of axiomatic field theory and uni-

tarity. From this extension it is clear that superconvergence conditions will appear as soon as at least one of the particles has a spin larger than one. The case of spin 0−spin 1 is marginal. It is only by making a dynamical assumption about the high-energy behavior of charge exchange amplitudes that one can obtain superconvergence in this case. Another limitation of the proof is the inherent weakness of field theory which limits considerations to stable particles. Thus the results apply to $\pi + d$ scattering (neglecting weak interactions) but not to $\pi + \rho$ scattering. (J.F.P.)

39498 HORN–SCHMID DUALITY. Chew, Geoffrey F. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 2: 74-7(May-June 1968).

Various developments leading from the recent revival and concrete indentification of the concept of "finite-energy sum rules" are discussed. A brief analysis of the Horn−Schmid duality is given. (L.B.S.)

39499 SPECIFIC PROPERTIES OF DIFFRACTION SCATTERING CROSS SECTION. Tishchenko, B. I.; Inopin, E. V. Yadern. Fiz., 7: 1029-36(May 1968). (In Russian).

A simple and consequent method for parametrization of the scattering matrix that is based on the expansion of its elements η_l into a series by the total system of functions, is proposed. It is shown that the number of necessary parameters depends on the scattering angle interval under investigation. Thus, at the scattering angles $\vartheta < 1$ it is usually sufficient to introduce five parameters. By means of the complex angular momenta method, analytical expressions for the cross sections of elastic and inelastic scattering are obtained and specific properties of diffraction scattering cross sections are analyzed. It is, in particular, shown that the scattering cross sections may have two angles of the cross section dip between which there is a region of oscillation damping. It is shown that the dips may take place for the neutral particle scattering as well. (auth)

Particle Accelerators

Refer also to abstracts 37965, 37998, 38778, 39252, and 39636.

39500 (BNL–12589) STEADY-STATE BEAM LOADING OF A STANDING WAVE LINAC RF SYSTEM. Lee, M. J. (Brookhaven National Lab., Upton, N. Y.). [1968]. 9p. (CONF-680515–23). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Two criteria which take into account the effects of steady-state beam loading are considered theoretically for the design of a linac rf system. In one, the power transferred to the linac cavity is maximized for maximum beam current. In the other, the system is designed so that phase compensation for beam loading is not required. In general, it is not possible to have a system which meets both criteria. It is also shown that for any system, zero phase compensation is always obtainable provided that the load susceptance is adjustable. However, zero phase compensation is not always attainable for a system in which the generator susceptance, line length or cavity coupling coefficient is the only adjustable parameter. (auth)

39501 (CEA-R-3443) CAUSES D'ACCIDENTS AUPRES DES ACCELERATEURS ET DISPOSITIONS DE RADIOPROTECTION. (Causes of Accidents Near Accelerators and Radiation Protection Arrangements). Joffre, Henri; Vialettes, Henry (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 25p. (In French). Dep.

Some typical accidents mentioned in the literature or happened in C.E.A. Research Centers are described. The accidents are analyzed to determine the main cause and get some experience. The interest of a centralized control for security, detection, and signalling devices used near every important accelerator is studied. (auth)

39502 (CERN–68-7(Vol.1), pp 415-27) CERN, PAST AND FUTURE. Amaldi, E. (Rome Univ. (Italy). Istituto di Fisica).

The history of CERN is reviewed from its inception to the beginning of 1968, with emphasis on accelerator development. (J.F.P.)

39503 (JINR–P9-3805) UMEN'SHENIE FAZOVYKH POTER' V SINKHROTSIKLOTRONE NA 680 MeV PRI POMOSHCHI KORREKTSII AMPLITUDY USKORYAYUSHCHEGO NAPRYAZHENIYA. (Reduction of Phase Losses in the 680-MeV Synchrocyclotron by Means of Correction of the Accelerating Voltage Amplitude). Enchevich, I. B.; Tomilina, T. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 21p. (In Russian). Dep.

Frequency-amplitude characteristics of the 680-MeV synchrocyclotron high-frequency system has a significant unevenness in band. Decrease of the accelerating voltage amplitude leads to the phase losses and to the reduction of intensity by 10-15% (due to these losses) as well as to the deactivation on corresponding radii and to the rise of the background radiation induced by the scattered beam. An additional pulse bias is created by the grid modulator (at the frequency of 18.5 and 15.5 MHz) on the grid of the high-frequency oscillator. This bias leads to the decrease of the unevenness of the amplitude characteristic and to the elimination of undesirable phenomena involved. (auth)

39504 (KFK–754) BEAM PROPERTY MEASUREMENTS AT THE KARLSRUHE ISOCHRONOUS CYCLOTRON. Hartwig, D.; Linder, W.; Loesel, M. E.; Schatz, G.; Schweickert, H. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Apr. 1968. 39p. Dep.

Results of measurements of the phase of the internal beam, the phase width of the internal beam, and the phase space volume of the external beam are presented. Descriptions of the methods and equipment used for the measurements are given. (W.H.K.)

39505 (N–68-14018) DIGITAL READOUT AND CONTROL SYSTEM FOR A 64-INCH (1.63-m) SCATTERING CHAMBER. Madson, Lawrence P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1968. 13p. (NASA-TN-D-4324). CFSTI.

An automatic digital position control system is described for a scattering chamber now in use with the 60-inch (1.52-m) cyclotron at the Lewis Research Center. It features programmed remote control of detector positions with accuracies of ±0.03 degree for these positions. The system has been in continuous operation for a period of 6 months and has resulted in a 20 percent saving in experiment running time. (auth) (STAR)

39506 (RPI–328-123, pp 53-63) INSTRUMENTATION DEVELOPMENT. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The linac remote data processing terminal, spark chamber development, rupture tests on mylar vacuum windows, and modifications to the large liquid scintillator tank are briefly discussed. (W.H.K.)

39507 (SLAC-PUB–437) CONSIDERATION OF THE USE OF FEEDBACK IN A TRAVELING WAVE SUPERCONDUCTING ACCELERATOR. Neal, R. B. (Stanford Linear Accelerator Center, Calif.). June 1968. 24p. (CONF-680621–1). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

The use of feedback with traveling-wave linear accelerators is discussed. Topics include optimum feedback in the TW accelerator with beam loading; fixed bridge ratio g in the TW accelerator with beam loading; power dissipation in the TW accelerator, resistive load, and feedback loop; filling time of TW accelerator with feedback; standing-wave superconducting structure with beam loading; and filling time of standing-wave structure. A comparison was made of the traveling-wave and standing-wave designs. (B.G.D.)

39508 (SLAC-PUB–438) SAMPLE PARAMETERS OF A TWO-MILE SUPERCONDUCTING ACCELERATOR. Neal, R. B. (Stanford Linear Accelerator Center, Calif.). June 1968. 15p. (CONF-680621–2). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

The results derived in a previous paper by R. B. Neal (SLAC-TN-68-1(1968)) was used to calculate a sample set of parameters for a superconducting version of the two-mile SLAC accelerator. The parameters were calculated at 1428 and 2856 MHz. (B.G.D.)

39509 (UCRL–18217) WAIST-TO-WAIST TRANSFER IN THIN-LENS OPTICS. Luccio, Alfredo U. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 17p. Dep. CFSTI.

Graphs are presented, which enable one to calculate quickly the waist-to-waist transport of a charged particle beam through a line in the thin-lens approximation. The method can be used also in dealing with accelerating electrostatic lenses (immersion optics). (auth)

39510 POWER SUPPLY AND CONTROL OF ACCELERATORS, WORKING ON THE PRINCIPLE OF THE TESLA TRANSFORMER. Egorov, A. A.; Panasyuk, V. S.; Radchenko, V. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 2, 18-23(Mar.-Apr. 1968). (In Russian).

A charging installation, developed for the construction of Tesla transformers, used as an accelerator element was described. The installation can be used in other cases. The circuit for the control of the electron beam was described. (tr-auth)

39511 EFFECT OF THE RESONANCE PERTURBATION OF THE ACCELERATOR MAGNETIC FIELD ON THE STABILITY OF THE PARTICLE MOTION DURING OPERATION OF THE ACCELERATING SYSTEMS WITH REVERSE COUPLING AT THE BEAM. Koshkarev, D. G.; Nikolaev, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 2, 14-16(Mar.-Apr. 1968). (In Russian).

The effects of the perturbation of the magnetic field on the stability of particle motion during operation of accelerator control systems with reverse coupling at the beam are described. The supplementary limitation of the size of the transfer coefficients in the chain of reverse coupling at the beam was found as a function of the amplitude and phase of the resonance harmonics. The formulas obtained were experimentally verified on the ITEF accelerator. (tr-auth)

39512 ING: A GOOD THING: UNDER CERTAIN CONDITIONS. McNeill, K. G. (Univ. of Toronto). Sci. Forum, 1: 10-11(Feb. 1968).

Pros and cons of the proposed Intense Neutron Generator (ING) to be constructed by Atomic Energy Canada Ltd. are discussed. ING is less than ideal in the sense that pure low energy nuclear physics, as currently carried out in Canadian universities and government laboratories, will play only a small part in the overall scheme. However, ING is more than a nuclear physics facility in that, as well as producing radioisotopes, it can provide facilities for research in fields of nuclear physics new to Canada, and can open up new fields in materials science, power technology, chemistry, and the biological sciences. One estimate is that pure and applied research in materials science, for example, should be charged with nearly 50% of the capital cost of the proposal. The proposed accelerator, which will provide the power for intense neutron generation, would be unique in the world as regards to both current and power, being at least 10 times more intense than any other proposed device. This factor will make possible many experiments which are extremely worthwhile and are at the present time impossible. For a scientific point of view ING would make a valuable contribution, but the very high cost of ING will effectively come from the research grants of other scientists and will prevent the expansion of other research fields. (BBB)

39513 ING: THE WRONG THING, IN THE WRONG PLACE, AT THE WRONG TIME. Parr, J. Gordon (Univ. of Windsor, Can.). Sci. Forum, 1: 8-10(Feb. 1968).

Criticisms are advanced against the construction of the Intense Neutron Generator (ING) as proposed by Atomic Energy of Canada Ltd. (AECL). It is suggested that ING, the largest and most expensive single undertaking in the history of Canadian scientific research, is the wrong installation to be constructed in the wrong place at the wrong time. It is the wrong project because there are more important ones needed. It is in the wrong place because government in-house research already consumes a disproportionately large fraction of funds available for scientific research. And this is the wrong time because nuclear research is less vital to Canada than is an economic application of the knowledge already gained. It is suggested that nuclear physics already consumes a disproportionate fraction of the Canadian research effort, and that a disproportionate amount of Canadian government funds is already invested in pure science and in government laboratories. Further, the cost of ING, even before it is designed, has escalated greatly, from a figure of ~$56 million suggested in 1965, to a figure of ~$20 million per year for 7 yr, followed by a gross operating cost of $15 million per yr, offset by revenue of $5 million per yr suggested in 1966. The latest figure of $175 million was referred recently. It is suggested that AECL's expertise should lie in the exploitation of U as a fuel for nuclear reactors. Its objective should be to design reactors, or reactor fuel elements, for international sale. The problems associated with such an aim ought to keep AECL Chalk River scientists, both pure and applied, busy for many years. (BBB)

39514 ARRANGEMENT FOR MAINTAINING CONSTANT THE RADIUS OF CURVATURE OF THE PATH OF A BEAM OF CHARGED PARTICLES IN A MAGNETIC FIELD. (to United Aircraft Corp.). British Patent 1,116,851. June 12, 1968. Priority date Oct. 5, 1964, United States.

A system is described for maintaining a constant radius of curvature of a beam of charged particles passing through a magnetic field. The accelerating voltage is detected and relayed to a control system which adjusts the magnetic field strength to keep the beam focused. (W.H.K.)

39515 SIMPLE CYCLOTRON TARGET-CURRENT INTEGRATOR WITH THE DIGITAL OUTPUT. Kosina, Zdenek (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 71(Feb. 1968). (In Czech).

A transistorized device for current integration in the range from 1 to 5000 μA is described. (auth)

39516 DEVICE FOR DIVIDING A BEAM OF PARTICLES EMERGING FROM A PARTICLE ACCELERATOR. (to CSF-Compagnie Generale de Telegraphie Sans Fil). British Patent 1,115,299. May 29, 1968. Priority date Dec. 27, 1965, France.

A rf beam separator is described for use at the output of an accelerator. (B.G.D.)

39517 MAGNETIC ANALOGUE OF ELECTRIC FIELD CONFIGURATIONS APPLIED TO THE CENTRAL REGION OF AN AVF CYCLOTRON. van Nieuwland, J.; M.; Hagedoorn, H. L., Hazewindus, N.; Kramer, P. (Philips Research Labs., Eindhoven, Nethlands). Rev. Sci. Instrum., 39: 1054-5(July 1968).

During the development of a new small type of cyclotron with four-fold symmetry in which the particles are accelerated by a fourth harmonic of voltage applied on two dees an extensive study of the cyclotron center was undertaken. (B.G.D.)

39518 STANDING WAVE HIGH ENERGY LINEAR ACCELERATOR STRUCTURES. Knapp, E. A.; Knapp, B. C.; Potter, J. M. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 39: 979-91(July 1968). (LA-DC-9261).

The design and operation of resonant linear accelerator tanks suitable for use in high energy proton and electron linacs is described. It is shown that construction of these tanks to operate in the $\pi/2$ mode yields systems with extraordinary field stability. Theoretical expressions and corresponding experimental observations are obtained for the behavior of cavity chains operating in the $\pi/2$ mode. The synthesis of the side coupled cavity chain, a biperiodic chain which combines high acceleration efficiency with $\pi/2$ mode field stability, is described. Extensions of $\pi/2$ mode operation to nonperiodic chains is also demonstrated. (auth)

39519 QUADRUPOLE FIELD IN CIRCULAR CONCAVE ELECTRODES. Hayashi, Tomonao; Sakudo, Noriyuki (Tokyo Univ.). Rev. Sci. Instrum., 39: 958-61(July 1968).

The fields in circular concave electrodes with both infinitesimal and infinite thickness are analyzed by giving appropriate boundary conditions, and the optimum electrode angles for approximating the ideal quadrupole field best are obtained. These angles are 44° for infinitesimal thickness and 37° for infinite thickness. These results are verified by field plotting method. The realization of these electrodes is also discussed. (auth)

39520 ING: FOR PARTICLE PHYSICISTS, ONLY INDIRECT HELP. Prentice, J. D. (Univ. of Toronto). Sci. Forum, 1: 11-13(Feb. 1968).

An evaluation is made of the possible contribution to Canadian scientific research of the planned Intense Neutron Generator (ING). With its 1-GeV proton beam providing more than 10 times the energy of the McGill University synchrocyclotron, and with a beam power unmatched by any accelerator in the world, ING may offer promise of an important facility for high-energy physicists and the development of elementary particle physics research in Canada. The intense secondary beams of mesons will be immensely powerful nuclear structure probes, but only of limited use in solving the problems of strong and weak interactions which now form the core of particle physics. The indirect effects of ING on Canada's small but expanding physics research program will probably be much greater than those of the few important experiments which may make use of its intense meson beams. Justification of ING on the basis of its pure research capabilities is discussed. Canada's cooperation with other nations in financing and building large accelerators is suggested as an alternative to its own heavy expenditure of money and scientific manpower in unilateral large-scale projects. (BBB)

39521 ING: A VEHICLE TO NEW FRONTIERS. Elliott, L. G.; Lewis, W. Bennett; Ward, A. G. (Atomic Energy of Canada Ltd., Chalk River). Sci. Forum, 1: 3-7(Feb. 1968).

The proposal by Atomic Energy of Canada Limited to build the Intense Neutron Generator (ING) is discussed. ING is primarily an original design for an advanced research instrument for the production of subatomic particles, especially neutrons and mesons. ING will consist of a linear accelerator almost a mile long that will propel a dense beam of protons toward a target of molten lead-bismuth. Surrounding the liquid metal target is a tank of heavy water, 8 ft in dia which, in turn, is surrounded by steel shielding 14 ft thick. Heat produced by the reaction of protons with the metal (equivalent to about 38 MW) is transferred away by heat exchangers. The protons are accelerated until they reach an energy of 1 BeV. When they strike the target, neutrons are produced by spallation. The heavy water slows down the neutrons, producing extremely dense fluxes at the inner end of hollow tubes which radiate from the target. These neutron beam tubes will deliver the neutrons for experiments. Many other tubes

provide irradiation facilities for isotope production, nuclear chemistry and studies of materials under irradiation. The basic reason for choosing the spallation reaction is to obtain neutrons with a minimum of heat. ING will also act as a meson source, producing 2 varieties of these nuclear particles (pi-mesons and mu-mesons). They result from the collision of the proton beam with a thin curtain of liquid lithium, which will fall through the proton beam. The ING accelerator would have to produce 65 MW of 1-BeV protons. Its feasibility is not in doubt, but it will require a major development effort. The problems lie in designing it so as to produce this beam efficiently, reliably and with a machine that is relatively inexpensive to build and maintain. (BBB)

39522 THE TARGET: AN UNDERESTIMATED COMPONENT OF LINEAR ACCELERATORS. Allard, Christian (EURATOM, Geel, Belg.). Euratom Rev., 7: 34-41(June 1968).

The development of a uranium target at the CBNM electron linac for neutron production is described. Topics discussed include target design, yield considerations, target monitoring, and recovery of a damaged target. (W.H.K.)

39523 GENERATION OF SHORT PULSES OF BREMSSTRAHLUNG AT THE 140-MeV BRAUNSCHWEIG SYNCHROTRON. Collin, W.; Guldbakke, S.; Kayser, K.; Reich, H.; Trier, J. O. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 25: 75-6(July 1968). (In German).

The use of the Hammer-Bureau Method for prompt destruction of the electron beam in a synchrotron is made possible without beam losses even under unfavorable geometrical conditions by disturbing the electron orbit in two steps, interruption of the hf accelerating voltage and delayed switching on the additional magnetic field. The pulse length of the 140-MeV synchrotron in Braunschweig is shortened from 50 μsec to 0.2 μsec. (auth)

39524 ELECTRON RING ACCELERATOR: A NEW ACCELERATION PRINCIPLE. [PART I]. Schopper, H. (Univ., Karlsruhe, Ger.). Phys. Bl., 24: 201-8(May 1968). (In German).

The principles of the electron ring accelerator are derived and outlined. The acceleration of the ring is discussed with respect to expansion acceleration and high frequency acceleration. (J.S.R.)

39525 THE UNIVERSITY OF MINNESOTA POLARIZED PROTON SOURCE. Boyd, R. N.; Hoot, C. G.; Poppe, C. H.; Sievers, J. A.; Williams, J. H. (Univ. of Minnesota, Minneapolis). Nucl. Instrum. Methods, 63: 210-14(Aug. 1968).

A new polarized proton source has been built and is in use on the University of Minnesota linear accelerator. This source utilizes an rf transition scheme and a strong field ionizer, together with an improved geometry, to almost double the polarization and produces a significant increase in beam intensity over the old University of Minnesota polarized proton source. Using the new source, the 40 MeV beam intensity (with a 1.2% accelerator duty cycle) is 4×10^7 protons/sec, and the polarization is 55%. (auth)

39526 ELECTRON ACCELERATOR MODIFICATIONS FOR PRECISE ATOMIC DISPLACEMENT THRESHOLD ENERGY DETERMINATIONS. Bryant, F. J.; Cox, A. F. J.; Kirbitson, R. (Univ. of Hull, Eng.). Nucl. Instrum. Methods, 63: 195-200(Aug. 1968).

Developments necessary to convert a commercial Van de Graaff 100–400 keV electron accelerator for precise atomic displacement threshold energy determinations have been described. By adding a specially designed electronic voltage stabilizer the electron beam energy fluctuations have been reduced to less than ±2 keV for irradiations which may extend over several hours. Auxiliary magnetic focussing, electrostatic deflection, and scanning of the electron beam have been provided so that small specimens in demountable cryostats may be irradiated in a controlled manner. The method used for calibrating the electron beam energy has been outlined. (auth)

39527 A TWIN-TARGET TECHNIQUE FOR THE MEASUREMENT OF NUCLEAR LIFETIMES BY THE DOPPLER SHIFT ATTENUATION METHOD. Currie, W. M.; Johnson, C. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 63: 221-9(Aug. 1968).

Doppler shift attenuation measurements of nuclear lifetimes are described for a technique which minimizes the effects of instabilities in the γ-ray detector. The excited nuclei are produced by passing a single beam through two targets, only one of which has a backing to attenuate the Doppler shift. Particles emitted during the production of the excited nuclei are detected by surface barrier counters associated with each target and the de-excitation γ-ray spectra from both targets are viewed by a single NaI(Tl) crystal. The use of particle-gamma coincidences serves to identify not only the nuclear excited state and the direction of nuclear recoil but also the target in which the event occurred. Thus simultaneous measurements are made on the γ-ray with and without attenuation of the Doppler shift. The lifetime is derived from the relative positions of the two gamma-ray peaks. Corrections are discussed for the effects of the finite detector geometries and for the details of the slowing down of the recoil nuclei. As a test case, the lifetimes of the 1.37-MeV and 4.23-MeV states in ^{24}Mg were measured to be $(1.51 \pm 0.17) \times 10^{-12}$ sec and $(8.3 \pm 1.6) \times 10^{-13}$ sec, respectively, in good agreement with earlier work. (auth)

39528 FOCUSING OF A BEAM OF FAST CHARGED PARTICLES IN AN ELECTROSTATIC MIRROR WITH A CYLINDRICAL FIELD. Zashkvara, V. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 38: 59-62(Jan. 1968). (In Russian).

An attempt is made to generalize the results obtained in a previous work for the case of relativistic charged particles, and to determine the feasibility of a second-order angular focusing of such beams in a cylindrical lens. It is concluded that the angular focusing method can be used to design an energy analyzer for relativistic charged-particle beams in the low energy range ($\epsilon/mc^2 \sim 1$). In this case, the cylindrical lens is superior to other analyzers, such as the spherical condenser or the magnetic beta spectrometer with longitudinal focusing, in terms of improved angular focusing [spherical aberration: $\sim(\Delta\alpha)3$], simplicity of construction, and the reliability in achieving axial field symmetry. (ATD)

39529 DEPOLARIZATION OF PARTICLES DURING ACCELERATION IN THE MAGNETIC SYSTEMS OF ACCELERATORS OF THE PHASOTRON AND CYCLOTRON TYPES. Abrosimov, N. K.; Osipov, G. V. (Physical-Technical Inst., Leningrad). Zh. Tekh. Fiz., 38: 93-9(Jan. 1968). (In Russian).

The depolarization of protons in weak-focusing constant-field cyclic accelerators is discussed. The magnetic field of the accelerator is expressed as the sum of the ideal axially symmetric field of the accelerator and a small perturbing field representing the effects of misalignment, inhomogeneity of the material of the magnetic circuit, and the like. The relativistic equations of motion of the polarization vector (spin) in the presence of field perturbations and free and forced betatron oscillations are integrated. It is found that at certain radii of the equilibrium orbit there occur resonances that contribute to the depolarization of the particles. The condition for the occurrence of a resonance and formulas for its position and contribution to the depolarization in terms of the Fourier components of the perturbing field are derived. Some of the present results were previously obtained but new resonances due to the presence of radial betatron oscillations are found and the contributions of the radial betatron oscillations to the resonances previously discussed are calculated. (ATD)

39530 STABILITY OF A MODULATED BEAM IN A DISK-LOADED WAVEGUIDE. Kurilko, V. I. Zh. Tekh. Fiz., 38: 118-28(Jan. 1968). (In Russian).

A self-consistent approximation for the radial oscillations of a charged-particle beam in a waveguide that limit the current in a linear accelerator are discussed. The calculations were undertaken because in previous treatments either the modulation (bunching) of the beam or the periodic structure of the waveguide was neglected, or the results were valid only for low beam current or for an infinite waveguide. The dispersion equation for the beam oscillations is derived and its roots are discussed in detail for the case when the ratio of the bunching length of the beam to the period of the waveguide is 4. It is shown that owing to the periodicity of the beam there are two most strongly excited spatial harmonics of the field, the interaction between which determines the growth rate of the instability. The growth rates and limiting currents are calculated, and the effect of the Q of the waveguide on the defocusing oscillations is discussed. The principal conclusions drawn by the author from his calculations are: modulation of the beam increases the limiting current only when the difference between the beam modulation frequency (the ratio of the beam velocity to the bunching length) and two-thirds of the resonant frequency of the radial defocusing oscillations is small compared with both the growth rate of the radial oscillations and the ratio of the resonant frequency of the oscillations to the Q of the waveguide; for a given current, the depth of the beam modulation does not affect the growth rate of the instability; when the waveguide is not matched to the frequency of the defocusing oscillations, the instability is absolute, the field increasing exponentially with time at every point in the section; and the limiting current can be increased by reducing the Q of the system. (ATD)

39531 INVESTIGATION OF PULSE SHORTENING EFFECTS IN MULTI-SECTION LINEAR ACCELERATORS. Zykov, A. I.; Grishaev, I. A.; Vishnyakov, V. A.; Mocheshnikov, N. I.; Kramskoi,

G. D. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 129-32(Jan. 1968). (In Russian).

An experimental investigation to determine the effects of the length of the accelerator, the geometry of the electron beam, and the stability of the electron beam's position on pulse shortening in extended high-energy electron accelerators is described. Transverse hybrid modes induced by the beam in iris waveguides and held responsible for the pulse-shortening effect were analyzed. An increase in the length of the accelerator was found to lower the threshold value of the current at which the beam disintegrates. Correct positioning of the beam along the axis of the system greatly increased the power level of the accelerator. It appears that a multi-section accelerator with a uniformly structured iris waveguide is nothing but a modified version of the backward-wave generator having a transverse field and a relativistic beam. Arrangements using accelerating sections with variable dimensions and a constant field, rather than constant structure, or combinations of shorter sections with hybrid frequency filters between them, would avoid the difficulty of pulse shortening. (ATD)

39532 CURRENT PULSE SHORTENING IN A TWO-SECTION LINEAR ACCELERATOR. Vishnyakov, V. A.; Zykov, A. I.; Grizhko, V. M.; Grishaev, I. A. Zh. Tekh. Fiz., 38: 133-8(Jan. 1968). (In Russian).

A two-section linear electron accelerator with an output energy reaching 40 MeV was designed for use in a study of the dependence of the critical current producing pulse shortening on electron energy, pulse duration, and the length of the accelerating waveguide. It is shown that the critical value of the current at which pulse shortening occurs increases linearly with increasing electron energy. The use of low-impedance iris waveguides is proposed for heavy-current accelerators. The length of the accelerating sections should not be increased excessively; it is more convenient to increase their quantity instead. Maximum energy gain should be attained by each accelerating section. Current pulse duration should not exceed the time required by the hybrid mode to establish itself in the system. The average beam intensity should be raised by increasing the pulse repetition rate rather than the pulse value of the current or the pulse duration. It is necessary to form sharply defined pulses with low phase dispersion which are free of parasite particles that do not participate in the acceleration process. (ATD)

39533 DYNAMICS OF PARTICLES IN A WAVEGUIDE BUNCHER. Vishnyakov, V. A.; Ostrovskii, E. K. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 139-42(Jan. 1968). (In Russian).

The authors briefly discuss the design and theoretical performance of an injection system for a linear electron accelerator. The discussed injection system consists of an electron gun producing a beam of 80-keV electrons, a prebuncher of the klystron type producing bunches with a phase extent of 60–80°, a septate waveguide buncher with a constant phase velocity of 0.75c that reduces the extent of the bunches to 10–15° and increases the energy of the electrons to 0.6–0.7 MeV, and a second septate waveguide bunching-accelerating section with a constant phase velocity of c that increases the electron energy to several tens of MeV and further improves the bunching. Both waveguide sections operate in a longitudinal magnetic field, and the system includes three magnetic lenses. With a 24-cm buncher and a 3-m accelerating section with an accelerating field of 120 kV/cm there should be obtained electron bunches with a phase extent of 5° and an energy spread of 2%. It is concluded that the buncher performs best when the electrons complete one-half of a phase oscillation within it, that increasing the electric field strength in the accelerating section reduces the phase extent of the bunches and the energy spread of the electrons within them, and that the optimum phase velocity and length of the buncher and the field strength within it depend on the initial energy of the electrons. (ATD)

39534 INVESTIGATION OF THE EH_{11} HYBRID WAVE IN A SEPTATE WAVEGUIDE. Kotov, V. I.; Yampol'skii, I. R. Zh. Tekh. Fiz., 38: 143-54(Jan. 1968). (In Russian).

Characteristics of the $\pi/2$ mode of the EH_{11} wave in septate waveguide sections of different dimensions, with particular attention to the ratio R/Q of the shunt resistance R to the waveguide Q-factor, and the ratio E_{max}/E_0 of the maximum field strength E_{max} in the waveguide to the equivalent deflecting field E_0 were measured. The measurements were undertaken for the design of high-frequency particle separators. Most of the measurements were made with a cavity resonator representing two waveguide sections and containing one full septum in the center and a shorted half-septum at each end. Field strengths were derived from the shift in the resonant frequency following introduction into the cavity of suitable foreign objects (a nylon sphere for measuring the field strength at the face of the septum, and a small metal tube for measuring the axial component of the electric field on the axis of the system); the requisite precision was achieved by employing a null method involving mechanical modulation of the resonant frequency. Waveguide sections containing 6 or 7 septa were employed to measure the dispersion characteristics and the group velocity of the waves. Attempts to determine the Q of the structure from the width of the pass band were unsuccessful, and in the subsequent discussion an average of the Q's of the CERN and Brookhaven structures was employed. The design of high-frequency particle separators is discussed briefly on the basis of the results obtained. It is concluded that for a given power level the intensity of the passed beam increases with increasing maximum field strength and decreasing group velocity; that, other conditions being equal, the separated beam intensity can be 10 to 15% higher for a structure with a positive group velocity than for a structure with a negative group velocity; that the intensity increases with increasing power level, the intensity increasing, for example, by 25% when the power is raised from 15 to 25 MW; and that the maximum field strength is not a critical factor, the intensity decreasing, for example, by only 8% when the maximum field strength is reduced from 240 to 175 kV/cm at a constant power level of 15 MW. (ATD)

39535 THEORY OF THREE-ELECTRODE ELECTRON GUNS EMPLOYING LONGITUDINAL COMPRESSION. Zinchenko, N. S. (Inst. of Radiophysics and Electronics, Kharkov). Zh. Tekh. Fiz., 38: 184-9(Jan. 1968). (In Russian).

The theory of a two-anode electron gun in which a retarding potential is applied between the first and second anodes in order to increase the perveance of the beam (increase of perveance by longitudinal compression) is discussed. A formula is obtained for the current density in the beam from a three-electrode gun in terms of the potentials on the two anodes and the current density in the beam when the two anode potentials are equal. Measurements of current densities in electron beams from a three-electrode gun developed at the Institute of Radiophysics and Electronics of the AN SSSR were found to be in good agreement with this formula. A scaling parameter is defined, which can be employed to design a three-electrode electron gun on the basis of the known performance of another one. It is concluded that the perveance of the beam from an electron gun can be advantageously increased by the use of a second retarding anode. (ATD)

39536 PROPERTIES OF HIGH-ENERGY BEAMS FROM A 600 MeV SYNCHROCYCLOTRON. Baarli, J.; Goebel, K. (CERN, Geneva). pp 1837-48 of Progress in Radiology. Vol. II. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967.

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.2).

The properties of the 600-MeV proton beam of the CERN Synchrocyclotron and the secondary beams of pions and high energy neutrons are described. Muons are also produced as secondaries from pion decay. Dosimetry techniques for high-energy radiation (above 150 MeV) are discussed in general. Specific details are presented for dosimetry of the main proton beam and secondary beams from the 600 MeV synchrocyclotron. (B.G.B.)

39537 AUTOMATIC DEVICE TO PREVENT THE BURNING OUT OF THIN TARGETS UNDER THE INFLUENCE OF ION CURRENT FLUCTUATIONS OF ACCELERATORS. Schlenk, B.; Valek, A. ATOMKI (At. Kut. Intez.) Kozlem., 10: 71-6(Apr. 1968). (In Hungarian).

The description of a simple automatic device for preventing the burning out of thin and gas targets under the influence of random fluctuations of ion current in accelerators. The automatic equipment is controlled by the output impulses of a current integrator. When the time elapsed between two successive integrator impulses is shorter than a given limit adjusted externally, i.e., the ion current exceeds a value considered allowable, the automatic device by the help of a magnetic switch closes the ion current in front of the target. (auth)

39538 MEASUREMENT OF THE AMPLITUDES AND PHASES OF THE RADIAL OSCILLATIONS IN THE CYCLOTRON BY MEANS OF TWO SAMPLERS. Krasnov, N. N.; Ognev, A. A.; Ponomarev, A. A. Prib. Tekh. Eksp., No. 2, 16-18(Mar.-Apr. 1968). (In Russian).

It was shown that by means of two samplers, moving along the axis between the dees, the amplitude and phase of the radial oscillations of the particles in the cyclotron can be controlled by measurement of the projection of the simultaneous orbital centers on the axis. (tr-auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 38029, 38797, 39303, 39522, and 39627.

39539 (AEET/NP-16) STUDY OF SLOWING DOWN AND DIFFUSION OF NEUTRONS IN LEAD USING A PULSED NEUTRON SOURCE. Chandramoleshwar, K.; Navalkar, M. P.; Phiske, M. R.; Ramana, J. V.; Ramkrishna, D. V. S.; Sadavarte, S. K. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.). Sept. 1965. 63p. Dep.

It is shown that in the near thermal region, the interaction between neutrons and moderator atoms in the case of Pb can be interpreted on the basis of a temperature difference between neutron gas and moderator gas. A new method that has been suggested for nondestructive assay of ^{239}Pu and ^{235}U burnup was experimentally verified. 42 references. (SB Raizada)

39540 (CEA-R-3170) THE C_n METHOD FOR APPROXIMATION OF THE BOLTZMANN EQUATION. Benoist, Pierre; Kavenoky, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 46p. (In French). Dep.

In a new method of approximation of the Boltzmann equation, one starts from a particular form of the equation which involves only the angular flux at the boundary of the considered medium and where the space variable does not appear explicitly. Expanding in orthogonal polynomials the angular flux of neutrons leaking from the medium and making no assumption about the angular flux within the medium, very good approximations to several classical plane geometry problems, i.e., the albedo of slabs and the transmission by slabs, the extrapolation length of the Milne problem, and the spectrum of neutrons reflected by a semi-infinite slowing-down medium. The method can be extended to other geometries. (auth)

39541 (GA-8626) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending March 31, 1968. Beyster, J. R.; Borgonovi, G. M.; Gozani, T.; (and others) (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 15, 1968. Contract AT(04-3)-167. 40p. Dep. CFSTI.

The contribution of approximations to inaccuracies in a first principles calculation of the phonon dispersion curve for Be was analyzed. The scattering law for CH_2 was calculated, using a force constant model, in the incoherent approximation; the scattering law was used to calculate the double differential cross section. In addition, the total cross section for CH_2 was also calculated; the results agree with experimental data within 3%. A relation that is independent of Ewald's splitting parameter was derived for the Coulomb contribution to the dynamical matrix for UO_2, and shell-model formalism was applied to the lattice dynamics of BeO. A comparison of exact and short collision results for the scattering law of H_2O was made. Transmission measurements of the neutron total cross section of UC_2 were performed. A reanalysis of spectrum measurements across a Triga fuel element showed that an apparent extreme sensitivity to the spatial source distribution was spurious. A large rare earth detector that was developed for intermediate energy spectral measurements was calibrated by comparing it with other detectors and by the measurement of standard spectra. (D.C.W.)

39542 (IN-1151) NEUTRON SCATTERING IN ORIENTED POLYETHYLENE AT 300, 77, AND 4.2°K. Myers, W. R. (Idaho Nuclear Corp., Idaho Falls). May 1968. Contract AT(10-1)-1230. 138p. Dep. CFSTI.

The absolute neutron scattering cross sections of oriented polyethylene were measured at temperatures of 300, 77, and 4.2°K using the MTR phased chopper velocity selector. Incident neutron energies of 30, 40, and 80 MeV were used. The target was oriented so that the transverse and longitudinal cross sections could be measured simultaneously in six (three each) separate scattering angles. Data are presented in the form of absolute scattering cross sections and are also shown converted to the amplitude-weighted directional frequency spectra. The conversion to frequency spectra includes use of measured Debye-Waller coefficients. Strong singularities are observed at phonon energies of 65, 25, 15.5, 12, and 5.6 MeV. Data for all the angles at the three temperatures and three incident energies are tabulated. (auth)

39543 (ITEF-537) VYBOR OPTIMAL'NOGO REZHIMA OBLUCHENIYA IZOTOPOV. (Selection of the Optimum Method of Irradiating Isotopes). Zaritskaya, T. S.; Rudik, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 14p. (In Russian). Dep.

Pontryagin's maximum principle was used to solve the problems of isotope irradiation processes. The maximum irradiation properties were analyzed, and necessary conditions were found for irradiation by the maximum neutron flux. The problem of neutron flux variations with time, determined by the classical variational principle, was studied. (R.V.J.)

39544 (KFKI-14/1968) CODE FOR THE CALCULATION OF MULTIGROUP CONSTANTS FROM A 26-GROUP SYSTEM OF MICRO-CROSS-SECTIONS. Vertes, Peter (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). June 11, 1968. 14p. Dep.

An algol procedure to calculate the multigroup constants from 26-group micro-cross sections is described. The tabulated micro-cross sections are written into magnetic tape backing store by special codes which are also discussed. The procedure is as simple as possible and needs a relatively small fast store. It has a short and a long version. In the latter, corrections are made for resonance self-shielding. (auth)

39545 (ORNL-TM-2252) SENSITIVITY OF NEUTRON TRANSPORT IN OXYGEN TO VARIOUS CROSS-SECTION SETS. Straker, E. A. (Oak Ridge National Lab., Tenn.). June 26, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The effect of several input cross-section sets on the results of neutron transport in an infinite medium of oxygen is determined. The detail with which the minimum in the cross section is represented significantly affects the neutron intensity at deep penetration. The importance of using angular distributions and total cross sections determined with approximately the same energy resolution is demonstrated by results obtained by combining parts of two different cross-section sets. In addition, the effect of various amounts of smoothing of the input cross sections over energy is also shown. In general, the slope of the $4\pi R^2$ dose curves at deep penetration is determined by the minimum in the total cross section as used in the code. (auth)

39546 (ORNL-tr-1952) PLE: A PROGRAM FOR THE NUMERICAL SOLUTION OF THE MULTIGROUP P_L-EQUATIONS WITH ARBITRARY ANISOTROPIC SCATTERING FOR PLANE LAYERS. (Technische Hochschule, Stuttgart (West Germany). Institut fuer Kernenergetik). Translated for Oak Ridge National Lab., Tenn., from German report. Dep. CFSTI.

The mathematical formulation of an ALGOL program for the numerical solution of multigroup P_L equations with anisotropic scattering for plane layers is presented. (D.C.W.)

39547 (RPI-328-123) LINEAR ACCELERATOR PROJECT. Progress Report, January 1, 1968–March 31, 1968. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 76p. Dep. CFSTI.

Separate abstracts were prepared for the seven sections of the report. (D.C.W.)

For abstracts of individual sections see: 39506, 39548–39552, and 39631.

39548 (RPI-328-123, pp 18-25) FAST REACTOR PHYSICS EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The analysis of time-of-flight measurements of fast neutron spectra in depleted uranium was continued, and computer programs were developed for analyzing time-of-flight data on fast neutron spectra. Preliminary results of measurements of position-dependent fast neutron spectra in iron are also reported. (D.C.W.)

39549 (RPI-328-123, pp 26-31) NEUTRON THERMALIZATION EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The phased chopper–linear accelerator technique was used with an on-line computer to measure time-dependent thermal neutron spectra in the center of a light water slab. (D.C.W.)

39550 (RPI-328-123, pp 32-8) LOW ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

The General Multiple Scattering Program was successfully run using a GASKET scattering law for H_2O in a realistic situation. The incident energy considered was 0.499 eV, and the sample thickness was 0.028 in. Correction factors were calculated for six angles, corresponding to an experimental arrangement. An attempt to resolve previously reported discrepancies between experimental data and theoretical predictions for double differential scattering on hot water was initiated. (D.C.W.)

39551 (RPI-328-123, pp 39-52) REACTOR PHYSICS THEORETICAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The development of methods for calculating flux spectra in fast reactors continued. The average scattering angle in energy-dependent problems was investigated. Some progress is reported in the determination of time moments of fast neutron slowing down in heavy media; the time moments were used to express the time-dependent neutron energy distribution by an expansion in orthogonal polynomials. The influence of re-entrant holes on space-dependent spectrum measurements was analyzed. An expression for the Doppler-broadened resonance cross section in terms of φ_n integrals was used to derive the temperature coefficient; the Doppler coefficient in fast reactors was also studied. A model that yields the neutron flux as a function of space, energy, and time in fast pulsed neutron assemblies was developed. (D.C.W.)

39552 (RPI-328-123, pp 64-72) MISCELLANEOUS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

A method for performing neutron diffraction studies using a pulsed electron linear accelerator was successfully tested. Studies involving the de-excitation of light and medium-weight nuclei following high-energy photon absorption were made; some reactions that can be applied in activation analysis were investigated. The use of photonuclear reactions to produce short-lived radionuclides was studied. (D.C.W.)

39553 (RT/FI-(68)14) EIGENFUNCTION EXPANSIONS IN SPACE-TIME NEUTRON DISTRIBUTIONS. Boffi, V. C.; Trombetti, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 22p. (CONF-660624-3). Dep.

From EAES Symposium on Advances in Reactor Theory, Karlsruhe, Ger.

The space-angle-time distribution of monoenergetic neutrons is studied for the case of plane symmetry using the Case method and assuming anisotropic scattering, constant cross sections, and heavy stationary nuclei. (D.C.W.)

39554 (SC-RR-68-19) THEORETICAL NEUTRON PRODUCTION FROM HYDROGEN ISOTOPE REACTIONS. Halbleib, J. A.; Scott, M. R. (Sandia Corp., Albuquerque, N. Mex.). May 1968. Contract AT(29-1)-789. 98p. Dep. CFSTI.

A program is presented for calculating neutron production characteristics for the three hydrogen isotope reactions using hydrated titanium targets and incident ion energies up to 5 MeV. It is further suggested how the basic code, which will compute the neutron current density at an arbitrary point in space, may be modified to extend its usefulness. In particular, a demonstration is given for using the code to determine the neutron differential energy spectrum at an arbitrary spatial position. (auth)

39555 (WAPD-TM-662) HYDROGENOUS-MATERIAL-DEPENDENT REMOVAL CROSS SECTION OF LEAD FOR FAST NEUTRON BIOLOGICAL DOSE. Dudziak, D. J.; Schmucker, J. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT-11-1-GEN-14. 14p. Dep. CFSTI.

A study has been made to determine the effective neutron removal cross section of lead, using the energy spectrum of a Po-Be neutron source, when the lead is followed by varying amounts of hydrogenous material (polyethylene). Using a one-dimensional modified P3 multigroup approximation to the Boltzmann transport equation, the flux spectrum and resulting dose rates were calculated for various thicknesses of lead with polyethylene thickness as a parameter. The resulting asymptotic value of the effective removal cross section of lead approximates currently published values for a fission source. (auth)

39556 (WAPD-TM-733) INTERFACE CONDITIONS FOR FEW GROUP EQUATIONS WITH FLUX-ADJOINT WEIGHTED CONSTANTS (LWBR DEVELOPMENT PROGRAM). Buslik, A. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1968. Contract AT-11-1-GEN-14. 24p. Dep. CFSTI.

Few-group diffusion equations are derived from variational principles. It is shown that by a proper choice of trial functions it is possible to derive a few-group theory in which interface boundary conditions of continuity of few-group fluxes and currents are obtained, even when the few-group constants are obtained by flux-adjoint weighting. The analysis is facilitated by the use of functionals which incorporate the interface condition of flux continuity by means of Lagrange Multipliers. Two functionals are used, giving two variants of the theory. Both functionals have as Euler equations the P-1 approximation to the time-independent, eigenvalue form of the energy-dependent transport equation. In addition, the current and flux interface boundary conditions are part of the complement of Euler conditions of the functionals. The functionals admit trial functions discontinuous in space and energy. The two functionals differ in that the one functional has both flux and current arguments, whereas the other functional has only flux arguments and yields the P-1 equations in second-order diffusion form. (auth)

39557 SLOW-NEUTRON INELASTIC SCATTERING AND THE DYNAMICS OF HEAVY WATER. Harling, O. K. (Battelle-Northwest, Richland, Wash.). Nucl. Sci. Eng., 33: 41-50(1968).

The results of an extensive slow-neutron inelastic scattering study of heavy water at 299°K are reported. High-energy resolution measurements were made on thin D_2O samples to obtain the double differential scattering cross sections for energy transfers to 7 kT and momentum ($\Delta\overline{P}/\hbar$) transfers to 9.5 $Å^{-1}$. A spectral density for the modes of motion in D_2O was obtained by an extrapolation technique. Experimental results are presented in the form of the Egelstaff scattering function and are compared with calculations based on the McMurry-Russell modification of the Nelkin model for water and the Egelstaff-Schofield theory for an incoherent scatterer with a Gaussian self-correlation function. (auth)

39558 NEUTRON KINETICS BASED ON THE EQUATION OF TELEGRAPHY. Niederauer, George Frederick. Iowa City, Iowa, Iowa State Univ., 1967. 77p.

Thesis.

The telegrapher's equation is applied to one-velocity kinetics problems in two types of one-dimensional homogeneous media: the semi-infinite medium and the infinite slab. A solution describing both the transient and the asymptotic behavior is presented for systems having an arbitrary source located at a boundary and having zero initial conditions. The method of solution involves Laplace transforming the telegrapher's equation, solving the resulting differential equation, and transforming back to the time domain. The Laplace transform of the equation is used to study the steady-state response to a sinusoidal boundary source. The telegrapher's equation is shown to be in good agreement with the diffusion equation for frequencies less than 10^4 rad/sec. It is found useful to introduce the concept of the infinite mean neutron transport time $\tau_0 = 3D/v$ as the distinguishing feature between the telegrapher's equation and the diffusion equation. In the study of the pulsed-neutron experiment the equation relating the decay constant and the geometric buckling contains additional terms which are due to τ_0. For $\tau_0 = 0$ the equation for the decay constant is the same as the one found in diffusion theory. The telegrapher's form of the decay constant has the condition on it that asymptotic decay constant do not exist for slab thicknesses less than a critical thickness $h^* = 3.60\,\lambda_{tr}$ (λ_{tr} = transport mean free path) for nonmultiplying media. The point reactor kinetics equations are derived from the telegrapher's equation. The difference between these equations and the equivalent set from diffusion theory is in the time-dependent part of the neutron balance equation. It is convenient to define the finite mean transport time $\tau = \tau_0(1 - 3D^2B^2)$. The transport times are related to the infinite and finite lifetimes l_0 and l by the identity $1/\tau - 1/\tau_0 + 1/l - 1/l_0 = 0$. The transfer function is derived from the kinetics equations; it differs from the diffusion equivalent by an additional factor $\tau(S + 1/\tau)$ in the denominator. The frequency analysis of the telegrapher's transfer function agrees with that of the diffusion transfer function at lower frequencies. The breakpoint at the frequency $1/\tau$ is a result of the difference between the diffusion and the telegrapher's transfer functions. At higher frequencies the phase angle is shifted downward another 90° and the slope of the magnitude is decreased by 20 db/decade. (Diss. Abstr.)

39559 INTERPRETATION OF THE PULSED NEUTRON DECAY CONSTANT IN HYDROGENOUS MEDIA. McCauley, Edward Willette. Seattle, Univ. of Washington, 1967. 183p.

Thesis.

A laboratory experiment was developed, and a corresponding, spectrally consistent, diffusion theoretic model was derived for the measurement of hydrogenous infinite medium neutron diffusion parameters by the pulsed source method. An experimental program was carried out to determine these parameters for methyl benzene. The experimental arrangement made use of a homogeneous moderator-detector employing the $^{10}B(n,\alpha)$ reaction for neutron detection as sensed by multiplier phototubes arranged in coincidence with a pulse shape discrimination system for gamma rejection. Boundary continuity in the cubical moderator containers was maintained by use of 40-mil cadmium sheet and a unique gadolinium-loaded glass. Data analysis techniques produced, in addition to the infinite medium diffusion parameters, consistent estimates of spectral assessment and augmentation distance. In addition to offering a new and useful approach to determination of the infinite medium diffusion parameters in hydrogeneous media the homogeneous moderator-detector makes possible comprehensive 3-dimensional time-dependent experiments which are fundamental to extending the understanding of neutron behavior in small systems. (Diss. Abstr.)

39560 DESIGN OF NEUTRON HOWITZERS. Cox, A. J.; Francois, P. E.; Gatrell, R. P. (Univ. of Aston, Birmingham, Eng.). Int. J. Appl. Radiat. Isotop., 19: 541-4(June 1968).

The distribution of the neutron flux from a howitzer that consisted of a Po–Be source with a paraffin moderator was measured as a function of the length and thickness of the side walls, the thickness of the backscatterer, the position of the source in the backscatterer, and the length and thickness of the central plug. (D.C.W.)

39561 SCATTERING OF NEUTRONS BY AN ANHARMONIC CRYSTAL. Hoegberg, T. Umea, Sweden, Umea Univ., 1967. 10p. Thesis.

A review is given of 3 published papers by the author on the following subjects: Green functions for an anharmonic crystal treated by functional methods; functional expansion and Green function techniques in scattering of neutrons by an anharmonic crystal; and scattering of neutrons by an anharmonic crystal. (Sweden)

39562 SOME PROPOSALS FOR THE APPLICATION OF COMPOUND MONOCHROMATOR CRYSTALS FOR NEUTRON DIFFRACTION AND SCATTERING MEASUREMENTS. Maier-Leibnitz, H. (Institut Laue-Langevin, Grenoble, France). Ann. Acad. Sci. Fenn., Ser. A. VI, No. 267, 1-17(1967). (In German).

It is proposed to construct a monochromator crystal of lamellae, each of which is tilted with respect to its neighbor at the mosaic η. The density d of the lamellae in the direction of the incident beam is selected so that a good reflection is obtained through the wave number region determined by the mosaic. The lamella are inclined to the beam direction in such a manner that the following is obtained: the lamellae n lie along the output beam direction so that the wave number region scattered in this direction is n times larger than that of a single lamella; and the inclination of the lattice plane is altered along a direction given by the lamella center of gravity in such a manner that an almost parallel incident beam is combined after reflection to a small surface. Generally such a system causes a transformation in the pulse space; from an approximately straight-line beam, there is one in which the pulse depends on the direction of emergence. Lamellar crystal systems have advantages in diffractions on powders and, in a somewhat different model than actual chromators, in inelastic scattering, especially of high-energy neutrons. For the practically important problem of the diffraction on small-single crystals, two new methods were proposed: a variation of the Laue method in which all n orders n(hkl) occur in different directions; and a focusing method for single reflections in which the inelastic scattering was preponderantly suppressed. (tr-auth)

39563 EFFECTIVE AND AVERAGE NEUTRON ENERGIES OF (α,n) SOURCES BEHIND HYDROGEN CONTAINING SHIELDING. Heinzelmann, M.; Nachtigall, D. (Kernforschungsanlage Juelich, Ger.). Health Phys., 15: 87-91(July 1968).

The measurements described show that Po–Be, Am–Be, and Pu–Be spectra moderated with hydrogen-containing shield material, such as compressed wood and polyethylene of a few thickness, have their effective energy E_e reduced to nearly 10%. Calculations on the basis of energy distributions of monoenergetic neutrons behind polyethylene shields lead to similar results. Since for unmoderated Po–Be, Am–Be, and Pu–Be spectra E_e = 4.8 MeV and d_e (dose equivalent conversion factor) = 3.5×10^{-8} rem cm^2, the values for moderated spectra can be taken as E_e = 0.5 MeV and $d_e = 2.2 \times 10^{-8}$ rem cm^2. On the other hand, the average neutron energy E behind hydrogen-containing shield material alters by only about 20 to 30% and increases at larger thicknesses. (auth) (UK)

39564 RECENT RESULTS AND APPLICATIONS USING A FLASH NEUTRON GENERATOR. Hollister, Herb (Kaman Nuclear, Colorado Springs). pp 302-5 of Nucleonics in Aerospace. Polishuk, Paul (ed.). New York, Plenum Press, 1968.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio. See CONF-670714.

A description is given of a flash neutron generator capable of producing short bursts of neutrons at peak rates four orders of magnitude greater than previously obtainable. The special properties of this source make it well suited for several applications. Some of the applications described are measurement of neutron ionization in semiconductor devices, measurement of fluorescent decay following neutron excitation, calibration of low sensitivity neutron detectors, short half-life activation analysis, and neutron radiography. (auth)

39565 SOME PROBLEMS IN FAST NEUTRON PHYSICS. Slaus, Ivo; Paic, Guy (Institut Rudjer Boskovic, Zagreb). pp 473-600 of Solid State Physics, Nuclear Physics, and Particle Physics. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968.

See CONF-670728.

The types of problems in nuclear physics that can be investigated using neutron-induced reactions are discussed, and a survey of experimental approaches and neutron sources is presented. The accuracy that can be achieved in neutron experiments is discussed, as are methods for analyzing the experimental data. (D.C.W.)

39566 STUDIES OF THE OPTICS OF NEUTRONS. VI. REMARKS ON A REPORT ON SLOW NEUTRON BEAMS. Halpern, Otto (American Express Co., London). Acta Phys. Austr., 26: 243-6(1967).

Attention is paid particularly to expressions for cross sections, to inelastic scattering and processes of spin-flipping, to magnetic scattering and to problems of polarization and depolarization. (auth)

39567 SPECTRAL DISTRIBUTION OF FISSION NEUTRONS IN ORDINARY CONCRETE. Lim, Myong-jai Gene. Charlottesville, Va., Univ. of Virginia, 1966. 120p. Thesis

Activation foil detectors were used to measure the fast neutron spectrum, slowing down age, and thermal diffusion length in concrete. The neutron source was a uranium fission plate placed in the graphite thermal column of the University of Virginia Reactor. Experimental concrete slabs were placed in the concrete biological shield of the reactor so that the medium was essentially infinite in the lateral direction. Indium, magnesium and aluminum threshold foils were used to map the fast flux; indium, gold, tungsten and manganese resonance foils to measure the neutron age; and indium and gold foils to measure the thermal neutron distribution. The fast spectrum retains essentially the fission shape with a slight dip in the 3 to 5 MeV range. The measured ages are essentially the same, 149 cm^2, to the indium, gold and tungsten resonances and 126 cm^2 to the manganese resonances. The thermal diffusion length was measured as 6.0 ± 0.5 cm. (Disser. Abstr.)

39568 TEMPERATURE DEPENDENCE OF NEUTRON SPIN PRECISSION FREQUENCIES UNDER CONDITIONS OF DIFFRACTION. Baryshevskii, V. G.; Korennaye, L. N. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 12: 25-6(Jan. 1968). (In Russian).

Neutron diffraction is polarized crystals was studied considering nuclear vibrations. The stationary neutron state in crystals was divided into two types, depending on the direction of the spin in relation to the polarization vector of the target. The energy spectrum for each group has its zonal character. It is shown that in polarized crystal the neutron (electron) spin precession frequencies are functions of temperature. (R.V.J.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 39433, 39554, 39576, and 39690.

39569 (COO-1195-131) DIFFERENTIAL CROSS SECTIONS FOR THE REACTION ^{4}He(γ,p)^{3}H FROM 55 TO 165 MeV. Stenberg, Charles Gustave (Illinois Univ., Urbana). 1968. Contracts NONR1834(05); AT(11-1)-1195. 122p. Dep. CFSTI.

Thesis.

Differential cross sections were measured for the reaction ^{4}He(γ,p)^{3}H for incident photons of 55 to 165 MeV. Outgoing protons and tritons from a low-temperature ^{4}He target were detected in coincidence at three angular settings in the laboratory: (θ_p, θ_T) = (59.5, 106°), (88.5°, 75°), and (118°, 47.5°). The triton detection system consisted of three semiconductor detectors followed by a plastic scintillator. The proton detection system consisted of four plastic scintillators and was large enough to collect all protons correlated with tritons in the triton system. The pulses from the calibrated detectors were used to identify the particles and measure their energies. The results show an exponential decrease in the differential cross sections with increasing gamma-ray energy with possible leveling off at the region of pion threshold. The angular distribution of the protons is peaked more strongly forward as the energy increases. A simple calculation relates the differential cross sections at the several angles to a common function of the proton or triton momentum. Results of this calculation are compared with the data. (auth)

39570 (LNF-68/6) FOTODISINTEGRAZIONE IN DUE CORPI DEL' ^{4}He NELL'INTERVALLO DI ENERGIA: 500 ≤ E_γ ≤ 750 MeV. (Photodisintegration in Two Bodies in ^{4}He in the Energy Interval: 500 ≤ E_γ ≤ 750 MeV). Note No. 391. Grilli, M.; Picozza, P.; Schaerf, C.; Scrimaglio, R.; Soso, F.; Spillantini, P.; Visentin, R.

(Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Feb. 28, 1968. 9p. (In Italian). Dep.

The differential cross section of the reaction $\gamma + {}^4He \rightarrow {}^3He + n$ was measured at $\theta_{CM} = 60°$ and $500 \leq E_\gamma \leq 750$ MeV. The method is outlined. A simultaneous measurement of the deuterons produced at $\theta_L = 40°$ and p_d (deuteron momentum) = 540 to 730 MeV/c revealed the change of the deuteron counts as a function of the deuteron momentum at 750 and 500 MeV. The differential cross section for the production of deuterons from ^4He at an angle of $\theta_L = 40°$ was determined. (J.S.R.)

39571 (N-68-15638) A SEARCH FOR UNBOUND ^3He LEVELS WITH ISOBARIC SPIN 1/2. Warner, Robert E.; Vincent, John S.; Boschitz, Edmund T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 14p. (NASA-TN-D-4377). CFSTI.

An attempt was made to excite the unbound $T = 1/2$ states in helium-3 by $(\alpha, {}^3He)$ inelastic scattering. No states in ^3He between 3- and 13-MeV excitation were found. The shape of the inelastic alpha particle spectrum was calculated with the assumption that phase space alone determines the shape. Precise fits to the observed spectra were not obtained, but the similarity between calculated and observed spectra gave evidence that a broad maximum in the 17.5° spectrum was caused by phase space rather than a level in ^3He. Other calculations with Baldin's formalism showed that no enhancement of the inelastic cross section near 8-MeV excitation in ^3He should be expected. (auth) (STAR)

39572 CALCULATION OF ENERGETIC DEUTERON MOMENTUM SPECTRA FROM PROTON–NUCLEUS COLLISIONS AT GeV. Rotsstein, A.; Van Ginneken, A. (McGill Univ., Montreal). Phys. Rev. Lett., 21: 223-6(July 22, 1968).

The momentum spectra of energetic deuterons in proton-nucleus collisions at 1 BeV have been calculated using Feynman-diagram techniques and are compared with the results of recent experiments. (auth)

39573 BREAKUP OF DEUTERON BY IMPACT OF ALPHA PARTICLE AND DEUTERON. Tanabe, Tetsumi (Kyoto Univ.). J. Phys. Soc. Jap., 25: 21-36(July 1968).

The $D(\alpha,p\alpha)n$ and $D(d,pd)n$ reactions were studied by using 29.2-MeV alpha particles and 14.6-MeV deuterons, respectively. Coincidence energy spectra of two charged particles emitted from each reaction were measured at coplaner and non-coplaner angles. The energy spectra of the $D(\alpha,p\alpha)n$ reaction indicate the effect of the resonance between nucleons and alpha particles corresponding to the ^5He and ^5Li ground state and show at some angles broad peaks for spectator neutrons with zero energy. The energy spectrum of the $D(d,pd)n$ reaction shows only one broad peak for spectator neutrons. The impulse approximation calculations represent fairly well both the energy spectra and the angular dependence. It is concluded that the deuteron breakup mechanism is to occur through the quasifree scattering of an incident particle from a nucleon in the deuteron. (auth)

39574 BINDING ENERGY OF THREE NUCLEONS. Hall, R. L. (London Univ.). J. Phys., A, 1: 468-74(July 1968).

A lower bound to the ground-state energy of a system of three nucleons is given in terms of the eigenvalues of a two-particle Hamiltonian. No special assumptions are made about the form of the ground state of the system. For a simple exponential exchange potential it is found that the triton energy is -8.1 ± 3.0 MeV and the trineutron energy is greater than -1.35 MeV. The method is quite generally applicable to current low-energy phenomenological potentials. (auth) (UK)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 37781, 39435, 39552, 39572, 39604, 39614, 39629, 39638, 39639, 39648, 39686, and 39714.

39575 (CEA-R-3279) CONTRIBUTION A L'ETUDE DE LA STRUCTURE NUCLEAIRE PAR DES MESURES DE SECTIONS EFFICACES NEUTRONIQUES ENTRE 400 keV ET 1200 keV: RESONANCES ISOLEES ET STRUCTURE INTERMEDIAIRE. (Contribution to the Study of Nuclear Structure Using Neutron Total Cross-Section Measurements Between 400 and 1200 keV: Isolated Resonances and Intermediate Structure). Cabe, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 136p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The neutron total cross sections were measured over the energy range 400 to 1200 keV for fluorine, aluminum, silicon, phosphorus, vanadium, chromium, manganese, iron, nickel, cobalt and lead with an energy spread of 3 keV. The neutrons were produced by the $T(p,n)^3He$ reaction; the proton beam was supplied by a 2-MeV Van de Graff. The structure in ^{56}Fe was studied in a more detailed way by measuring six angular distributions in the above range and the elastic scattering excitation curves at four angles. The measurements have made it possible to show the existence of the compound nucleus, as well as the presence of an intermediate structure in certain nuclei. (auth)

39576 (CEA-R-3392) CONTRIBUTION TO THE STUDY OF LIGHT NUCLEI WITH POLARIZED DEUTERONS. Arvieux, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 223p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

The vector- and tensor-polarized deuteron source associated with the Saclay fixed-energy (22 MeV) cyclotron is described. This has been used to measure the deuteron asymmetry in d-α scattering (between 17.7 and 21.4 MeV) and in d-p scattering at 21.7 MeV. The formalism of irreducible tensor operators used to describe the polarization of a particle of given spin is developed, and the helicity formalism used to describe the scattering amplitudes for scattering of deuterons by α (spin 0) and protons (spin $1/2$) is studied. The preceding results are applied to the phase-shift analysis of scattering cross sections, to deuteron polarization in d-α scattering from 10 to 27 MeV, from which indications about the excited states of ^6Li are obtained; and to proton and deuteron polarizations in p-d (or d-p) scattering from 1.5 to 12 MeV so as to get the splitting (due to spin interactions) of P and D waves. (auth)

39577 (CONF-670970, pp 161-77) A STUDY OF THE $^9Be(^3He,n)^{11}C$ REACTION IN THE ENERGY RANGE 3.5 TO 10 MeV. Okano, K.; Kikuchi, S.; Nishimura, K.; Harada, K. (Japan Atomic Energy Research Inst., Tokyo).

Neutron angular distributions and excitation functions for the reaction $^9Be(^3He,n)^{11}C$ to the ground and first excited states of ^{11}C were measured at bombarding energies of 3.5 to 10 MeV. Similar data for the $(^3He,p)$ reaction on ^9Be were taken from other sources. The reaction $^9Be(^3He,n)^{11}C$ was fairly well accounted for by DWBA calculations based on the two-nucleon stripping process in the energy region above about 5 MeV. (D.C.W.)

39578 (CONF-670970, pp 243-52) INVESTIGATION OF THE $^9Be(^3He,t)^9B$ REACTION IN THE 3.0 TO 3.8-MeV REGION. Nakagawa, T.; Nakagome, Y.; Orihara, H.; Tohei, T.; Ueno, H.; Yamaya, T.; Baba, M. (Tohoku Univ., Sendai, Japan).

The mechanism of the reaction $^9Be(^3He,t)^9B$ was investigated by measuring the angular distribution and the excitation function for the reaction to the ground state of ^9B at ^3He energies of 3.0 to 3.8 MeV. Momentum analysis of the tritons was carried out with a magnetic spectrometer, and energy analysis was performed by a solid-state detector. The experimental data were fitted using the PWBA knock-on and heavy-particle stripping theory. (D.C.W.)

39579 (EUR-3950) EVALUATION OF THE $^{10}B(n,\alpha)$ CROSS SECTION AND BRANCHING RATIO. Gubernator, K.; Moret, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1968. 35p. Dep.

Available data on the $^{10}B(n,\alpha)$ cross section and the branching ratio in the range from thermal energy to 1 MeV are compiled. After a critical evaluation, a set of data is selected to compute recommended values and best curves of the (n,α) cross section and the branching ratio, for neutron energies up to 100 keV. The σ_{n,α_1} cross section is derived. At thermal energy $\sigma^0_{n,\alpha} = (3835 \pm 14)$b and $R^0 = 6.308 \pm 0.012$ are recommended, the errors corresponding to confidence limits (95%). From thermal energy to 100 keV, best curves are recommended on the basis of least squares fits to the experimental data. The formula for $\sigma_{n,\alpha} = f(E)$ contains terms to correct for non-1/v behavior from the eV range up to 100 keV. The confidence interval gradually decreases from ±14b (thermal) to ±0.06b (100 keV). R = constant = 6.3 ± 0.3 up to 30 keV. From 30 to 100 keV, higher-order terms are proposed to fit the data. All recommended values and curves are summarized in the last chapter of this report, together with a set of numerical values. (auth)

39580 CLUSTER MECHANISM CONTRIBUTIONS IN $^{10}B(^3He, \alpha)^9B$ REACTION. Taffara, L. (Univ., Trieste, Italy); Vanzani, V. Nuovo Cim., 56B: 166-72(July 11, 1968).

It is pointed out that the difficulties arising from the interpretation of the $(^3He,\alpha)$ reactions can be overcome by applying the Feynman-diagram technique. The cluster triangle graph con-

tributions are studied in order to disclose the reaction mechanisms. Angular distributions up to 90° for the reaction $^{10}B(^3He, \alpha)^9B$ at 5.5 MeV and the excitation function at 30° are calculated. Satisfactory agreement with experimental data is obtained. (auth)

39581 DIRECT PHOTODISINTEGRATION OF ^{6}Li. Mititel, E. G.; Timashev, S. F. (Inst. of Physico-Chemical Research, Karpov, USSR). JETP Lett. (USSR) (Engl. Transl.), 7: 215-18 (Apr. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 277-80(Apr. 20, 1968).

The reaction $^6Li(\gamma,np)^4He$ was studied in the electric dipole approximation. The matrix elements corresponding to the possible diagrams for the reaction were calculated. A formula relating the differential cross section of the ground-state reaction to the differential cross section for photodisintegration of the free deuteron was obtained. (D.C.W.)

39582 OBSERVATION OF THE ANOMALY NEAR THRESHOLD IN COLLISIONS OF PROTONS WITH THE Be NUCLEI AT THE ENERGY 2.06 MeV. Siksin, V. S.; Baz, A. I.; Domoratskii, V. N.; Voronin, A. N.; Marchenko, V. S.; Kosinskii, G. E.; Kudryavtsev, A. N.; Batyshchev, G. D. (Rostov State Univ., Rostov-on-Don, USSR). Yadern. Fiz., 7: 950-3(May 1968). (In Russian).

The interaction of protons with the nucleus Be^9 in the energy region 2 to 2.1 MeV was investigated near the threshold of the reaction $Be^9(p,n)B^9$. The energy dependence of differential cross sections of elastic scattering of protons on the Be nuclei under the angles 45 and 60° in the lab system was measured. A sharp peak, 2 to 3 keV wide, in the threshold region at the energy 2.06 MeV; some structure in the proton energy region 2.04 to 2.05 MeV; as well as the peak at the proton energy 2.07 MeV are observed. The states near threshold can apparently be assigned to the states 1^-, 2^-, and the states with $j \leq 3^+$. (auth)

39583 VELOCITY DEPENDENCE OF THE TWO-PARTICLE POTENTIAL IN THE ONE PARTICLE-ONE HOLE MODEL OF ^{16}O AND ^{12}C NUCLEI. Harms, Ulrich (Univ., Goettingen, Ger.). Z. Naturforsch., 23a: 453-64(Mar. 1968). (In German).

The odd-parity states of ^{16}O are calculated in the 1-particle 1-hole model using the velocity-dependent forces of Herndon et al., and Green. In addition, some states of ^{12}C are calculated. It is found that the potential of Herndon et al., gives a satisfactory agreement with experiment, comparable with that of the Kallio-Kolltveit force. (auth)

39584 TEST OF TIME REVERSAL INVARIANCE IN BETA DECAY OF ^{19}Ne AND BETA DECAY ASYMMETRIES. Wick, Gerald Lee. Berkeley, Calif., Univ. of California, 1967. 78p.

Thesis.

A test of time reversal (T) invariance in the beta decay of ^{19}Ne was performed. Delayed coincidences of the positron and recoil F^- ion from decays in flight of an atomic beam of nuclear spin polarized ^{19}Ne were recorded. From this information the time reversal coefficient, D, and the neutrino asymmetry coefficient, B, were determined. Since the final-state correction to D is negligibly small for this measurement one would expect D = 0 unless T is violated. For the V-A theory of beta decay one would expect B = –1. The results of this work are: $D = +0.002 \pm 0.014$ and $B = -0.90 \pm 0.13$. The positron asymmetry coefficient, A, was measured by capturing polarized ^{19}Ne in a bulb and detecting counts parallel and anti-parallel to the spin. There was no noticeable relaxation of the spins in this measurement. The value for this coefficient is $A = -0.039 \pm 0.002$. It is customary to discuss the question of time reversal in terms of the phase angle, θ, between the complex vector and axial-vector coupling constants of beta decay. Time reversal invariance implies that this angle be $\theta = 0°$ or 180°. The coefficient D is proportional to $\sin\theta$. The quadrant may be determined from A + B which is proportional to $\cos\theta$. It is found that $\theta = 180.2° \pm 1.6°$. This is consistent with T invariance. It also adds confirmation to the V-A theory of weak interactions. (Diss. Abstr.)

39585 DIFFERENTIAL CROSS SECTIONS FOR A DIRECT NUCLEAR REACTION LEADING TO A MULTI-PARTICLE FINAL STATE. Henderson, Billy Joe. Athens, Ga., Univ. of Georgia, 1967. 77p.

Thesis.

Angular distributions for fixed values of the proton momentum, and proton momentum distributions for fixed angles are calculated for the reaction $^6Li(^3He,p\alpha)^4He$. The possibility of proton exchange between the incident ^{3}He and the proton in the deuteron is included. In order to assess the sensitivity of the calculation with respect to the wave functions, two different wave functions are used for ^{3}He. Zero-range, point-nucleus, and finite-range approximations for some of the potentials are compared. Parametric studies are done with respect to the cutoff radius, the proton energy, and constants which appear in the wave functions. The calculation assumed PWBA stripping theory, including nuclear recoil but neglecting spin. (Diss. Abstr.)

39586 EXPERIMENTAL INVESTIGATION OF CLUSTER STATES IN ^{15}O. Shrivastava, Prakash Narayan. Austin, Tex., Univ. of Texas, 1966. 84p.

Thesis.

^{14}N was bombarded with protons of energy between 6 and 11.5 MeV, and the angular distributions and the integrated cross sections were measured for the emergent charged particle groups. A broad resonance centered around a proton energy of 7.5 MeV was found to have a large reduced width for α-particles leading to the ground state of ^{11}C. This can be accounted for by a $(^{11}C + \alpha)$ cluster formation in this state. It was argued that if a $(^{11}C + \alpha)$ cluster was formed at 7.5 MeV, about 2.0 MeV higher a $(^{11}C^*(2.0\ MeV) + \alpha)$ cluster may also be formed. A search showed no indication of such a cluster state being formed. The cross sections for elastic and inelastic scattering of neutrons between 13 and 21 MeV from ^{12}C were measured. Neutrons from a (d,T) source were incident on a spherical shell of carbon at the center of which was placed a stilbene detector with an n-γ discrimination circuit. At 19.6 MeV the elastic cross section shows a resonance with half width of about 1.2 MeV. This resonance is qualitatively similar to one in ^{13}N first reported by B. B. Kinsey (Phy. Rev., 99: 332(1955)). An increased probability of elastic re-emission is characteristic of single particle states, but it is unlikely that a single particle state occurs at this high incident energy. The resonance is rather narrow to be a giant resonance. The work was performed to study this resonance. A proton recoil telescope for neutrons was constructed. It consists of a polyethylene radiator foil and three proportional counters in series followed by a thin CsI scintillator. An absolute measurement of the flux of monoenergetic neutrons in the energy range of 4 to 25 MeV can be made with this instrument. The ratio of L to K fluorescent yields in ^{198}Hg was measured by using a thin (1 mm) NaI scintillator. ^{198}Hg forms on the beta decay of ^{198}Au which was produced by neutron irradiation of thin foils of ^{197}Au in the Triga Mark I reactor at the University of Texas. This experiment was performed because a large L/K ratio may indicate the existence of γ transitions that have energy less than the binding energy of the K-electrons in the atom. The (p,p') and (p,n) cross sections for ^{63}Cu and ^{65}Cu were measured in the proton energy range of 6 to 12 MeV. A solid-state detector was used for proton measurements and a long counter was used for neutrons. In a magnetic field that varies as 1/r electrons and positrons can be made to go in opposite directions in trochoidal paths. The focusing property of such paths makes it possible to obtain a high transmission spectrometer for electron-positron pairs. Such an instrument is under construction. It will be useful for measurements on $O^+ - O^+$ transitions and for measurement of internal and external pair conversion coefficients. (Diss. Abstr.)

39587 NEUTRON–HELIUM SCATTERING AT ENERGIES BELOW 8 MeV. Morgan, George Lake. Durham, N. C., Duke Univ., 1967. 191p.

Thesis.

Precision relative differential cross sections for the scattering of neutrons from helium were measured at 22 neutron energies between 0.2 and 7.0 MeV. The measurements were made by observing the energy distribution of the recoiling helium nuclei in a high-pressure helium gas scintillation counter irradiated by monoenergetic neutrons. The $^7Li(p,n)^7Be$, $^{12}C(d,n)^{13}N$, $T(p,n)^3He$, and $D(d,n)^3He$ reactions were used as neutron sources. Pulsed beam techniques were employed in conjunction with two-dimensional pulse-height analysis by an on-line computer in order to acquire detailed information on the correlation between time-of-flight and scintillation pulse height for the radiation incident on the counter. This procedure allowed discrimination against events in the counter produced by gamma rays and energy degraded neutrons. Studies were conducted of the energy resolution and energy-to-pulse height conversion characteristics of the helium scintillation counter. The results of these studies were used to correct the measured helium recoil distributions for instrumental effects. Additional corrections were made for multiple scattering on the basis of distributions calculated by a random walk procedure. An analysis of the data was made in terms of phase shifts. A major problem encountered in the analysis was the lack of accurate total cross section data required to convert the relative distributions to absolute differential cross sections. Previous investigations had shown the s-wave phase shift to be well represented by a hard-sphere phase shift. Therefore, an alternate normalization procedure was adopted whereby the distributions at each energy were normalized such that they were consistent with a s-wave phase shift given by the hard sphere value for that energy. The data could be satisfactorily represented without the use of partial

waves higher than l = 1. The p-wave phase shifts, extracted from the data under normalization with a s-wave hard-sphere radius of 2.44 fermis, were found to have an energy dependence in good agreement with that predicted by single level dispersion theory. The extracted phase shifts were also found to be in good agreement with recent measurements of the angular dependence of the polarization of neutrons scattered from helium at 1.0, 2.0, 2.4, and 6.0 MeV. The p-state level parameters were determined to be $\gamma^2_\lambda(P_s)$ = 7.89 MeV, $E_\lambda(P_s)$ = −4.93 MeV and $\gamma^2_\lambda(P_s)$ = 23.0 MeV, $E_\lambda(P_s)$ = 1.97 MeV for an interaction radius of 3.0 fermis. The internal eigenfunctions were defined for a boundary value of 0.0. The possibility of representing the neutron-helium interaction by means of a two-body potential was investigated. A Saxon-Woods potential was found to give a good representation of the scattering. The parameters defining this potential were in general agreement with those determined in the optical model analysis of scattering from heavier nuclei. Calculations also showed that this potential gave a good description of proton-helium scattering. (Diss. Abstr.)

39588 SINGLE- AND MULTI-NUCLEON TRANSFER REACTIONS INDUCED BY OXYGEN IONS ON ^{10}B AND ^{11}B. Okuma, Yasuhiko (Kyoto Univ.). J. Phys. Soc. Jap., 25: 1-13(July 1968).

The excitation curves of the differential cross section at a center-of-mass angle of 90° for the transfer reactions, $^{10}B(^{16}O,^{18}O)^{11}B$, $^{10}B(^{16}O,^{15}N)^{11}C$, $^{10}B(^{16}O,^{14}N)^{12}C$, $^{10}B(^{16}O,^{17}O)^{9}B$, $^{10}B(^{16}O,^{17}F)^{9}Be$, $^{10}B(^{16}O,^{20}Ne)^{6}Li$, $^{11}B(^{16}O,^{15}N)^{12}C$, $^{11}B(^{16}O,^{14}N)^{13}C$, $^{11}B(^{16}O,^{17}O)^{10}B$, $^{11}B(^{16}O,^{18}F)^{9}Be$, and $^{11}B(^{16}O,^{20}Ne)^{7}Li$, leaving the reaction products in their ground states, were investigated by using the oxygen ions accelerated in the Kyoto University tandem accelerator. Measurements were made for energies near and above the Coulomb barrier appropriate to the ^{16}O + ^{10}B and ^{16}O + ^{11}B colliding systems. To distinguish these reactions from other events, the two product particles were identified by means of the two-detector fast-slow type coincidence system. The single-nucleon transfers show smooth energy dependence and the multi-nucleon transfers exhibit complicated energy dependence. The smooth excitation curves increase sharply with energy around the Coulomb barrier and level off at energies just barely touching. The differential cross sections are strongly Q-dependent. The cross sections for pick-up transfers are about 2.3 times as large on an average for ^{10}B as for ^{11}B. The transfer-reaction data are compared with the predictions of the tunneling theory, and good agreement is found for the initial rise of the smooth excitation curves. (auth)

39589 j-FORBIDDEN (d,p) STRIPPING REACTIONS ON ^{12}C, ^{16}O, AND ^{24}Mg. Hosono, Kazuhiko (Kyoto Univ.). J. Phys. Soc. Jap., 25: 36-51(July 1968).

High-resolution studies of the (d,p) reaction on ^{12}C at 14.6 MeV, ^{16}O at 14.3 MeV, and ^{24}Mg at 12.3 MeV were performed. The $^{12}C(d,p)^{13}C$ reaction leading to the ground and the 3.68-MeV states was also investigated from 14.7 down to 12.3 MeV. Some transitions which can not be explained by simple stripping process were observed. Most of angular distributions of protons from the j-forbidden stripping reaction showed a structureless pattern and the cross section was 10 ~ 30% of that of simple stripping process. Simple PWBA analyses based on the two-step process and on the knock out process were made and a possibility of the two-step process is suggested. The structure of some excited states is discussed in connection with the reaction mechanism. (auth)

39590 DISTRIBUTION OF BINDING ENERGY IN A NUCLEUS AND FISSION. Kohut, M.; Harvey, M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 46: 1491-8 (June 15, 1968). (AECL-3118).

The concept of distribution of binding energy is considered for a "realistic" two-body potential and realistic kinetic energy with the ^{16}O nucleus treated as an example. The relation with the nuclear fission process is discussed. (auth) (CANADA)

39591 SINGLET DEUTERON (d) FORMATION BY NEUTRON PICKUP FOR ^{9}Be + p. Nagatani, K. (California Inst. of Tech., Pasadena). Phys. Lett., 27B: 187-9(July 8, 1968).

It is shown that a PWBA calculation of $^{9}Be(p,d)^{8}Be$ provides good agreement with the experimental data consisting of energy spectra, the angular distribution, and the cross-section ratio of $^{9}Be(p,d)^{8}Be$ to $^{9}Be(p,d)^{8}Be$. (auth)

39592 NUCLEAR STRUCTURE OF ^{16}O AT HIGH EXCITATION ENERGY FROM $^{12}C(\alpha,\alpha)^{12}C$. Carter, E. B. (Trinity Univ., San Antonio). Phys. Lett., 27B: 202-6(July 8, 1968).

A phase-shift analysis of $^{12}C(\alpha,\alpha)^{12}C$ angular distributions was made, and levels in ^{16}O were deduced. Additional "rotational" bands in ^{16}O are apparent. (auth)

39593 FINAL-STATE INTERACTIONS IN (e,e'p) EXPERIMENTS. Watt, A. (Univ. of Aberdeen, Scotland). Phys. Lett., 27B: 190-1(July 8, 1968).

The angular distribution of protons in (e,e'p) experiments is shown to be quite strongly dependent on the interaction between the ejected proton and the residual nucleus. A simple method of accounting for this interaction is suggested. (auth)

39594 ELASTIC SCATTERING OF 104-MeV ALPHA PARTICLES. Hauser, G. (Univ., Heidelberg); Loehken, R.; Rebel, H.; Schatz, G.; Schweimer, W.; Specht, J. Phys. Lett., 27B: 220-2 (July 8, 1968).

The differential cross sections for the elastic scattering of 104-MeV α particles from nine target nuclei were measured. All angular distributions show a pronounced diffraction pattern. For the lightest nuclei measured (^{6}Li to ^{16}O), the cross section exceeds the Rutherford cross section by a factor up to 10 at angles around 30°. (auth)

39595 INFLUENCE OF CORE EXCITATIONS ON ONE-PARTICLE AND PARTICLE-HOLE GREEN'S FUNCTIONS. Manakos, P. (Technische Hochschule Darmstadt, Ger.). Z. Phys., 214: 57-70(1968).

An approximation method for the coupling of collective states with particle and hole states is derived by a partial summation of the perturbation series. The approximation is applied to low-lying, normal parity states of ^{17}O and ^{15}O as well as to the giant dipole resonance of ^{16}O. (auth)

39596 POLARIZATION OF ^{3}He ELASTICALLY SCATTERED BY ^{12}C AND THE ^{3}He SPIN-ORBIT OPTICAL POTENTIAL. Hutson, R. L. (Univ. of Colorado, Boulder); Hayakawa, S.; Chabre, M.; Kraushaar, J. J.; Ridley, B. W.; Boschitz, E. T. Phys. Lett., 27B: 153-5(June 24, 1968).

A double scattering experiment was performed to obtain an estimate of the polarization of ^{3}He ions of about 40 MeV elastically scattered from ^{12}C. Elastic cross sections were measured at 36 and 42 MeV. An optical model analysis was made of the cross-section and polarization data. It was found that optical model calculations were consistent with the experiment only if the optical model spin-orbit potential depth was less than or equal to about 3.5 MeV, in contrast with the 12 to 14 MeV found for protons. (auth)

39597 BETA END-POINT ENERGY FOR THE SUPERALLOWED FERMI DECAY $^{14}O(\beta^+)^{14}N$. Freeman, J. M. (Atomic Energy Research Establishment, Harwell, Eng.); Jenkin, J. G. Robinson, D. C.; Murray, G.; Burcham, W. E. Phys. Lett., 27B: 156-8(June 24, 1968).

Accurate measurements of the threshold for the reaction $^{14}N(p,n)^{14}O$ and of the energy of the first excited state of ^{14}N have provided a new value for the beta end-point energy in the Fermi decay of ^{14}O. The result is somewhat lower than the value currently used for ft calculations. (auth)

39598 DETERMINATION OF THE MULTIPOLE ORDER OF ELECTROMAGNETIC TRANSITIONS IN ^{11}B, ^{12}C, ^{16}O, AND ^{28}Si. Coffin, Jean-Pierre (Univ., Strasbourg). Ann. Phys. (Paris), 2: 273-92(Sept.-Oct. 1967). (In French).

Thesis.

A Siegbahn–Slätis magnetic spectrometer was modified to permit the determination of the multipolarity of electromagnetic transitions. The multipole characters of the four following transitions were studied: 8.92 MeV → 0 in ^{11}B; 6.49 MeV → 0 in ^{11}C; 3.63 MeV → 0 in ^{16}O; and 6.88 MeV → 0 in ^{28}Si. The results lead to assignments of $^5/_2^-$ for the 8.92-MeV level of ^{11}B; $^3/_2^-$, $^1/_2^-$, or $^7/_2^-$ for the 6.49-MeV level of ^{11}C; and 0^+ for the 3.63-MeV level of ^{16}O. It is shown that the 6.88-MeV level of ^{28}Si is probably 3^-. (D.C.W.)

39599 MECHANISM OF SINGLE-CHARGE-EXCHANGE BY PION AND NUCLEON INDUCED REACTIONS. Richter, A.; Chatwin, R. A. (Florida State Univ., Tallahassee). Phys. Lett., 27B: 181-3(July 8, 1968).

Cross sections of (p,n) and (π^+,π^0) reactions at medium energies on ^{10}B, ^{11}B, ^{13}C, and ^{14}N are compared with a simple charge exchange model. A single particle process does not describe the reactions on ^{14}N. (auth)

39600 THE $^{19}F(d,p)^{20}F$ NUCLEAR REACTION AT THE BOMBARDING ENERGY E_d = 600 keV. Schlenk, B.; Zimányi, J. (Koezponti Fizikai Kutato Intezet, Budapest). ATOMKI (At. Kut. Intez.) Kozlem., 10: 9-16(Apr. 1968). (In Hungarian).

The angular distributions of ten proton groups from the nuclear reaction $^{19}F(d,p)^{20}F$ were determined at a bombarding energy of E_d = 600 keV. On the basis of the DWBA model, using the potential parameters employed by P. R. Chagnon, it was possible to give an interpretation to five proton groups involved. In addition to reproduction of the angular distribution curves, the spectroscopic factors obtained by DWBA calculation are also acceptable. With

reference to the calculations with different potential parameters, it may be stated that, under the given conditions involving very low deuteron bombarding energies, the DWBA analysis is largely independent of the incertainties involved in deuteron optical potentials. (auth)

39601 CALCULATIONS OF THE NUCLEON POLARIZATION IN REACTIONS $^{12}C(d,n)^{13}N$ AND $^{12}C(d,p)^{13}C$. Babenko, N. P. Yadern. Fiz., 7: 1037-42(May 1968). (In Russian).

The polarization in reactions $^{12}C(d,n)^{13}N$ and $^{12}C(d,p)^{13}C$ is calculated by means of the distorted-wave approximation in order to investigate the dependence of the polarization on the cut-off for the radial integrals, the Q-value, and the Coulomb effects. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 37781, 39527, 39552, 39575, 39589, 39594, 39598, 39628, 39635, 39638, 39639, 39648, 39654, 39684, and 39685.

39602 (CONF-670970-, pp 101-15) SPECTROSCOPY IN THE N = 50 MASS REGION. Bassani, G.; Picard, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Some investigations of the configurations in N = 49 and 50 nuclei by ^{3}He-induced reactions are discussed. The proton configurations in nuclei with the closed N = 50 neutron shell were investigated using the (^{3}He,d) reaction on ^{92}Mo, ^{88}Sr, and ^{90}Zr. Neutron configurations were investigated using the (^{3}He,α) reaction on ^{92}Mo, ^{88}Sr, ^{89}Y, and ^{90}Zr. (D.C.W.)

39603 (CONF-670970-, pp 147-59) INVESTIGATION OF PARTICLE-HOLE STATES IN CALCIUM ISOTOPES BY (^{3}He,α) AND (^{3}He,d) REACTIONS. Lynen, U.; Santo, R.; Stock, R.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg, Ger.).

Particle-hole admixtures were investigated using the reactions ^{42,44}Ca(^{3}He,d) and ^{42,43,44}Ca(^{3}He,α) at an incident ^{3}He energy of 18 MeV. Angular distributions are presented for some of the transitions observed; and spectroscopic factors are given for states in ^{41}Ca, ^{42}Ca, and ^{45}Sc. (D.C.W.)

39604 (CONF-670970-, pp 179-228) 1p-1h AND 2p-1h STATES BY MEANS OF (^{3}He,d) AND (^{3}He,p) EXPERIMENTS. Seth, Kamal K. (Northwestern Univ., Evanston, Ill. CEN de Saclay, Gif-sur-Yvette, France).

The results of an experimental investigation of the reactions ^{115}In(^{3}He,d)^{116}Sn, ^{15}N(^{3}He,d)^{16}O, ^{15}N(^{3}He,p)^{17}O, ^{39}K(^{3}He,d)^{40}Ca, and ^{39}K(^{3}He,p)^{41}Ca are summarized. The interpretation of the data is outlined. (D.C.W.)

39605 (CONF-670970, pp 253-70) SOME EXPERIMENTS WITH ^{3}He IONS AT IPCR CYCLOTRON. Kamitsubo, H. (Institute of Physical and Chemical Research, Tokyo (Japan)).

Preliminary results of an investigation of ^{3}He elastic and inelastic scattering by ^{27}Al, ^{40}Ca, and ^{58}Ni and of the reaction ^{27}Al(^{3}He,α)^{28}Al are presented. Optical-model parameters used in the analysis of the data are included. (D.C.W.)

39606 (LA-tr-68-18) RADIATIVE CAPTURE OF FAST NEUTRONS. Abramov, A. I.; Van'kov, A. A.; Kononov, V. N.; Malyshev, A. V.; Stavisskii, Yu. Ya.; Tolstikov, V. A.; Shapar, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from a report. 14p. Dep. CFSTI.

A research program on the radiative capture of fast neutrons is briefly discussed, including absolute measurements in spherical geometry, detection of capture gamma rays, activation measurements, and theoretical calculations of cross sections. (D.C.W.)

39607 DIFFERENTIAL ABSOLUTE CROSS SECTION FOR THE NUCLEAR REACTIONS ^{27}Al(d,p)^{28}Al AND ^{27}Al(d,α)^{25}Mg AT θ_D = 90°. Corleo, G.; Sambataro, S. (Univ., Catania, Italy). Nuovo Cim., 56B: 83-8(July 11, 1968).

Absolute differential cross sections for the reactions ^{27}Al(d,α)^{25}Mg and ^{27}Al(d,p)^{28}Al at θ_L = 90° in the deuteron range 1.6 to 2 MeV were measured with a precision better than 12%. A comparison between the experimental cross sections averaged on the whole energy range and the Hauser-Feshbach calculations were made. (auth)

39608 LEVEL STRUCTURE OF ^{45}Ca FROM THE ^{44}Ca(d,pγ)^{45}Ca REACTION. Brandolini, F.; El Nadi, L.; Filosofo, I.; Pellegrini, F.; Signorini, C. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 56B: 137-48(July 11, 1968).

Gamma radiation studies from the reaction ^{44}Ca(d,pγ)^{45}Ca observed at a deuteron bombarding energy of 5 MeV, have established that the 1.90-MeV and 1.43-MeV states of ^{45}Ca both have angular momentum $J^\pi = 3/2^-$. The 1.90-MeV level is shown to de-excite with a relative intensity of 12% to the 1.43-MeV state, of 68% to the 0.176-MeV state and of 20% to the ground state. The 1.43-MeV level is shown to de-excite with a relative intensity of 70% to the 0.176-MeV state and of 30% to the ground state. In addition, for the transition to the 1.90-MeV of ^{45}Ca, the p-γ angular correlation was measured in the reaction plane with the proton counter on the peak of the stripping curve at 25°. The observed gamma angular correlation and the corresponding axis of symmetry are in agreement with the predictions of DWBA theory. Finally, experimental values of the multipole mixing parameter δ were deduced, and the experimental branching ratios were compared with the predictions of the shell-model theory. Satisfactory agreement between experiment and theory is obtained assuming an effective neutron charge of 0.6e. (auth)

39609 CROSS SECTION OF THE REACTION ^{40}Ca(γ,p). Goryachev, B. I.; Ishkhanov, B. S.; Kapitonov, I. M.; Piskarev, I. M.; Shevchenko, O. P.; Shevchenko, V. G. Yadern. Fiz., 7: 944-9(May 1968). (In Russian).

Cross sections of the reaction ^{40}Ca(γ,p) for the photoprotons with energies $E_p \geq 2$ MeV and $E_p \geq 6.5$ are calculated from the curves of the photoproton yield measured by means of semiconductor silicon detectors. The structure of the cross sections is compared with the predictions of the particle-hole model. It is shown that the high-energy states of ^{40}Ca are of a different nature as compared with the 1d-2s shells in nonmagic nuclei and that they are not related to a large excitation of the core of the finite nucleus. (auth)

39610 SEARCH FOR PARITY NONCONSERVATION IN ^{57}Fe BY STATIC MOESSBAUER ABSORPTION. Emmons, Donald Alton. St. Louis, Washington Univ., 1967. 103p.

Thesis.

The self-interacting current hypothesis of Feynman and Gell-Mann for the weak interaction implies a weak nucleon-nucleon coupling with the same parity nonconserving properties as the beta decay interaction. The most sensitive tests for parity admixing in nuclear states involve asymmetry or circular polarization in gamma transitions, since these are sensitive to the amplitude of the anomalous parity wave function. Interference between states of opposite parity gives rise to circular polarization of decay quanta which can be greater than the mixing ratio F because of retardation effects. It is assumed that the electromagnetic interaction is parity conserving. This thesis reports on an effort to extend the result of Grodzins and Genovese, who first looked for parity mixing in the 14.4-keV transition of ^{57}Fe using the Moessbauer effect. Recently Kankeleit has also performed a Moessbauer absorption velocity scanning experiment and reported a polarization of $2 \pm 6 \times 10^{-5}$. Resonance absorption of low-energy nuclear radiation (Moessbauer effect) allows the direct observation of hyperfine components resolved by the large effective magnetic field at the iron nucleus. For longitudinally magnetized iron these components are circularly polarized, and if equal substate populations exist then unequal intensities would indicate a net circular polarization arising from parity nonconservation. In the present experiment two of the hyperfine lines of one polarization sense from ^{57m}Fe in magnetized iron are resonantly absorbed in a static geometry by two lines of ^{57}Fe in Fe_2O_3. This fortuitous overlap in energy was mentioned by Kistner and Sunyar in their study of quadrupole splitting and the isomer shift. The intensity of the transmitted beam is detected at an angle of twenty degrees to the axis of source magnetization, and the asymmetry being sought is generated by reversing the magnetization. In order to avoid the effects of gain drifts, the magnetic field direction was alternated rapidly and the corresponding 14.4-keV discriminator pulses stored in separate scalers. To ensure that counting times were equal for each field direction, all pulses were passed through a supervisoty gate whose half cycle open time was independent of field direction and excluded switching transients. In order to deduce a circular polarization from the measured asymmetry it is necessary to know the fraction of polarized radiation resonantly absorbed at zero velocity. Some general features of Moessbauer absorption are discussed along with a general treatment for polarized hyperfine components. The construction of a velocity spectrometer is described, and experimental absorption spectra are used to determine a polarimeter efficiency of approximately 10%. More than 3×10^5 counts for each field direction were accumulated. The degree of circular polarization is measured as

$-0.1 \pm 1.9 \times 10^4$. Wahlborn has estimated a theoretical value of $P \leq 2.6 \times 10^{-5}$. Systematic errors in the various experimental approaches, and some methods of improving the polarimeter efficiency are discussed. (Diss. Abstr.)

39611 DECAY OF THE SECOND 2^+ STATE OF ^{44}Ca. Walter, H. K.; Weitsch, A.; Welke, H. J. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 213: 323-32(1968). (In German).

In ^{44}Ca, the E2/M1 mixing ratio $\delta = +0.137 \pm 0.017$ of the $2_2^+ \rightarrow 2_1^+$ transition and the B(E2) branching ratio of 3.3 ± 1.0 for the $2_2^+ \rightarrow 2_1^+$ transition relative to the $2_2^+ \rightarrow 0_1^+$ transition were determined by studying the decay of ^{44}Sc. In terms of a model of deformed excited states, the quadrupole moment of this deformation is estimated: $Q = -0.23$ b. (auth)

39612 THE NUCLEAR MAGNETIC MOMENT AND BETA DECAY ASYMMETRY OF ^{35}Ar. Calaprice, Frank Paul. Berkeley, Calif., Univ. of California, 1967. 131p.

Thesis.

The nuclear magnetic dipole moment of ^{35}Ar and the beta-decay asymmetry parameter for the mirror transition $^{35}Ar \rightarrow {}^{35}Cl$ (ground state) were measured by an atomic beam technique. The angular distribution of electrons emitted from nuclei with polarization P is proportional to $(1 + A\, v/c\, P \cos\theta)$, where v is the electron velocity and θ is the angle between the electron velocity and the spin polarization axis. ^{35}Ar decays to three levels of ^{35}Cl, with the primary branch (93%) to the ground state. Because this transition involves no change in spin ($\frac{3}{2} \rightarrow \frac{3}{2}$), it is a mixture of both Fermi and Gamow-Teller radiations. The transitions to the two excited levels are pure G-T transitions. Since the asymmetries for pure G-T transitions are independent of the matrix elements, the ground-state asymmetry parameter can be determined by measuring the average asymmetry of the three transitions. To polarize the nuclei, a beam of ^{35}Ar atoms in the $^1S_0$ atomic state is formed by thermal effusion from a source at 77°K and passed through a conventional "Stern-Gerlach" magnet. The polarized beam then travels through a nuclear magnetic resonance coil, located in a uniform C field, and is eventually collected in a cylindrical glass bulb, where most the ^{35}Ar nuclei decay. Although the atoms remain in the bulb long enough to make $\approx 10^5$ wall collisions, the nuclei retain their initial polarization. Two Geiger counters outside the bulb detect positrons emitted parallel and antiparallel to the polarization axis. The normalized difference between the count rates of the two counters is proportional to the asymmetry parameter A. Nuclear magnetic resonance in the C field is observed by detecting a partial reversal of the nuclear polarization in the bulb. The magnitude and sign of the nuclear magnetic moment μ are determined with a transverse oscillating rf field and a rotating rf field, respectively. The result, corrected for diamagnetic shielding, is $\mu = +0.633 \pm 0.002$ nm. The asymmetry parameter for the ground-state transition is $A_0 = 0.196 \pm 0.043$. By use of this value, the ratio $\rho_0 = C_A\langle\sigma\rangle/C_V\langle 1\rangle$ is calculated to be $\rho_0 = -0.12 \pm 0.03$. The comparative half-life is calculated and, together with ρ_0, is used to calculate the vector coupling constant, with the result $G_V(^{35}Ar) = 1.407 \pm 0.029 \times 10^{-49}$ erg-cm^3. Since the uncertainty in $G_V(^{35}Ar)$ due to ρ_0 is only 0.4%, a better measurement of the comparative half-life could yield a value of $G_V(^{35}Ar)$ comparable to the best results for pure Fermi decays. On assumption that $C_A/C_V \approx -1$, the Gamow-Teller matrix element is determined from ρ_0 to be $\langle\sigma\rangle \approx +0.12 \pm 0.04$. Both $\langle\sigma\rangle$ and μ are compared with predictions of nuclear models. Of the models considered, Nilsson's rotational model gives results in closest agreement with the experiment. (Diss. Abstr.)

39613 CIRCULAR POLARIZATION OF NEUTRON-CAPTURE GAMMA RAYS FROM ^{23}Na AND ^{31}P. Eichler, J. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 213: 352-60(1968). (In German).

The circular polarization of γ rays following the capture of polarized thermal neutrons in a target of ^{23}Na and ^{31}P was measured. The degree of polarization yielded the spin $I = 2^+$ for the 0.563-MeV level of ^{24}Na. For the 6.53-MeV γ transition from the compound state to the 0.563-MeV level, the mixing ratio $\delta = 0.26$ between E2 and M1 radiation was deduced. The measurement is consistent with the spin value $I = 2^+$ of the 2.95 keV resonance for thermal neutron capture of ^{24}Na. For ^{32}P the earlier spin assignment $I = 1^+$ for the 1.149-Mev level was confirmed. An upper limit $0 < \delta < 0.15$ for the mixing ratio of the 6.8-MeV capture γ transition was established. (auth)

39614 STUDY OF LEVELS IN ^{24}Mg. Ollerhead, R. W.; Kuehner, J. A.; Levesque, R. J. A.; Blackmore, E. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 46: 1381-1401(June 15, 1968). (AECL-3102).

Nineteen levels in ^{24}Mg were studied utilizing the reaction $^{12}C(^{16}O,\alpha\gamma)^{24}Mg$. Angular correlation measurements have established the spins and parities of levels at excitation energies of 7.35, 7.56, 7.62, 8.44, 8.65, 9.00, 9.15, and 10.1 MeV as 2^+, 1^-, 3^-, 1^-, 2^+, 2^+, 1^-, and 0^+, respectively. Levels at 8.12 and 13.18 MeV have been identified as the 6^+ and 8^+ members of the K = 0 ground-state rotational band; levels at 7.81 and 9.52 MeV were identified as the 5^+ and 6^+ members of the K = 2 rotational band based on the 2^+ level at 4.23 MeV. The existence of doublets has been established at excitation energies of 8.44 and 9.52 MeV; in each case, one member of the doublet is populated in the beta decay of ^{24}Al, and the present experiment indicates that these two levels have spin and parity 4^+. Assignments are also suggested for levels at 7.75 MeV (1^+) and 8.36 MeV (2^+). Gamma-ray spectra have been obtained for levels at 8.86, 9.28, and 9.46 MeV. The properties of levels assigned to rotational bands are compared to the predictions of the rotational model for an axially symmetric nucleus. (auth) (CANADA)

39615 MODEL OF EXCITED NUCLEAR CORE AND THE PROPERTIES OF NUCLEAR LEVELS OF ^{27}Al. Antropov, A. E.; Zarubin, P. I.; Kudryashov, V. I.; Orlov, B. N.; Plavko, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1734-9(Oct. 1967). (In Russian).

The applicability of the excited-core model for the description of the low-lying levels of ^{27}Al was investigated using the elastic and inelastic scattering of protons with energies of ~6 MeV on ^{27}Al and ^{28}Si. (R.V.J.)

39616 PROTON–NEUTRON TWO-PARTICLE EXCITED STATES OF THE $(1g_{\frac{9}{2}})^2_{9+}$ CONFIGURATION. Lu, C. C.; Zisman, M. S.; Harvey, B. G. (Univ. of California, Berkeley). Phys. Lett., 27B: 217-19(July 8, 1968).

The (α,d) reaction on separated target ^{52}Cr, ^{54,56}Fe, ^{58,60,62}Ni, and ^{64,66,68}Zn was studied at four angles with the 50-MeV α-particle beam from the Berkeley 88-inch cyclotron. Excited states of the residual nuclei with $(\pi 1g_{\frac{9}{2}}, \nu 1g_{\frac{9}{2}})9+$ configuration are suggested. (auth)

39617 THE $^{39}K(p,\gamma_0)^{40}Ca$ REACTION BETWEEN 2.9 AND 6.0 MeV. Bartko, J.; Thwaites, T. T. (Pennsylvania State Univ., University Park). Phys. Lett., 27B: 212-14(July 8, 1968).

The excitation function of the reaction $^{39}K(p,\gamma_0)^{40}Ca$ was measured from 2.88 to 6.01 MeV bombarding energy. Some resemblance is found to the predictions of particle-hole calculations particularly above 13-MeV excitation. (auth)

39618 LEVELS OF ^{37}Cl NUCLEUS AT EXCITATION ENERGIES OF 10.4 TO 10.6 MeV IN $^{36}S(p,\gamma)^{37}Cl$ REACTION. Ievlev, Yu. P.; Koval', A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Inst. of Physics and Tech., Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1740-2(Oct. 1967). (In Russian).

Excitation functions for the reaction $^{36}S(p,\gamma)^{37}Cl$ were measured at proton energies of 2.05 to 2.30 MeV. The resonance positions were determined, and calculations of the corresponding excitations were made considering a reaction Q-value of 8399 ± 8 keV. (R.V.J.)

39619 INVESTIGATION OF THE MULTIPLICITY OF THE NEUTRON YIELD IN μ CAPTURE BY COPPER. Bobodzhanov, I. B.; Dzhuraev, A. A.; Nazarov, A. F.; Rura, H. M. (Inst. of Physics and Tech., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 11: No. 2, 18-21(1968). (In Russian).

The mean multiple neutron production in a single event of μ^- capture by Cu nuclei was studied. Experimental data obtained on the yield of neutrons in the μ^- capture by various nuclei $\mu^- + Z^A \rightarrow (Z-1)^{A*} + \nu_\mu$ indicated a strong dependence of the multiple neutron production on the atomic number of the element described by $\bar{n} = \alpha A^b$ (where $\alpha = 0.30 \pm 0.02$). Tabulated data obtained by measuring the mean multiple neutron production during an event of μ^- capture by Cu nuclei show good agreement with the relation $\bar{n} = \alpha A^b$. (R.V.J.)

39620 SHELL MODEL APPLIED TO SOME CALCIUM ISOTOPES. Denning, A.; Haigh, J. G. B.; Brown, G. (Univ. of Bradford, Eng.). Phys. Lett., 27B: 159-60(June 24, 1968).

Spectroscopic factors were obtained for the l = 2 (d,p) transitions to the $1d_{\frac{5}{2}}$ hole states of ^{41}Ca at incident energies of 10 MeV and 12 MeV and ^{43}Ca and ^{45}Ca at an incident energy of 10 MeV. Values are obtained which are consistent with shell-model calculations. Comparison with the data for $E_d = 7$ MeV shows that compound-nucleus effects are important at lower incident energies. (auth)

39621 THE WIDTHS OF THE 9.991- AND 10.165-MeV LEVELS IN ^{27}Al. de Kock, P. R.; Koen, J. W.; Mouton, W. L. (Univ. of Stellenbosch, S. Afr.). Ann. Phys. (N. Y.), 47: 461-8(May 1968).

Gamma radiation from the decay of two resonances in the reac-

tion $^{26}Mg(p,\gamma)^{27}Al$ at E_p = 1.785 MeV and 1.965 MeV was resonantly absorbed in aluminium to excite the states at 9.991 and 10.165 MeV, respectively. In addition the γ-decay of the resonances was studied in detail, and angular distribution and yield measurements of the ground-state radiation performed. Spin-parity assignments are proposed for the 9.991- and 10.165-MeV levels, and values of Γ_T, Γ_p, and Γ_γ are given for the two levels. The spin of the 9.629-MeV state in ^{27}Al, excited at E_p = 1.409 MeV, was also determined and found to be ½. (auth)

39622 INFLUENCE OF INELASTIC SCATTERING ON (n,2n) CROSS SECTIONS OF ^{35}Cl AND ^{39}K. Peto, G.; Bornemisza-Pauspertl, P; Karolyi, J. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 24: No. 1, 93-6 (1968).

The cross sections of the reactions $^{35}Cl(n,2n)^{34g,m}Cl$ and $^{39}K(n,2n)^{38g,m}K$ were determined: the results are 1.7:7.6 and 5.1:0.8 mb, respectively. The excitation function of the reaction $^{39}K(n,2n)^{38g}K$ was measured in the neutron energy region 13.4 to 15 MeV. The discrepancy between the experimental (n,2n) data and the values calculated on the basis of the statistical model can be explained by the actual spectrum shape of inelastically scattered neutrons. (auth)

39623 CONVERSION-ELECTRON AND γ-RAY EXPERIMENTS WITH THE DECAY OF ^{82}Br AND ^{83}Sr. Etherton, Robert Cleland. East Lansing, Mich., Michigan State Univ., 1967. 147p.

Thesis.

The energy levels of ^{82}Kr populated by the beta decay of ^{82}Br were studied. The internal conversion electron spectra were recorded with permanent-magnet electron spectrometers and the singles and coincidence spectra were recorded using both NaI(Tl) and Ge(Li) detectors. A total of 21 transitions were identified. Excited states in ^{82}Kr were placed at 772, 1475, 1821, 2094, 2429, 2560, 2648, 2652, and 2832 keV. Angular correlation measurements for eight of the prominent gamma–gamma cascades were made, and the results were used to make unique spin assignments for the 777-, 1475-, 1821-, 2094-, and 2648-keV states. Transitions for the 2832-, 2652-, and 2560-keV states and log-ft values were used to place limits on the possible spin assignments for these states. The level structure of ^{82}Kr was used to test some of the predictions of the Davydov–Filippov asymmetric rotor model. Similar experiments as those described for the investigation of ^{82}Br were performed with the decay of ^{83}Sr. An M2 isomeric transition was identified at 42.3 keV. Some sixty transitions were identified enabling the placement of excited states at 5.0, 42.3, 295.2, 389.2, 423.5, 736.8, 804.8, 994.2, 1043.7, 1053.7, 1103.0, 1202.0, 1242.6, 1273.1, 1324.6, 1653.1, 1756.9, 1783.5, 1916.7, 1952.2, 2014.8, 2090.0, 2147.8, 2179.3 keV. Limits on the spins and parities of these states were placed on the basis of gamma-ray branching and log-ft values. An attempt was made to correlate the level structure of ^{83}Rb to that of ^{82}Kr with the core-coupling model. No simple relationship was found. (Disser. Abstr.)

39624 MEASUREMENT OF THE RATIO OF ELECTRON CAPTURE TO POSITON EMISSION IN THE DECAY OF ^{22}Na. Vatai, E. ATOMKI (At. Kut. Intez.) Kozlem., 10: 17-25(Apr. 1968).

The ϵ/β^+ ratio of ^{22}Na was measured to be 0.1042 ± 0.0010, which differs from both the uncorrected and exchange-corrected theoretical values. Data for other low-Z nuclei are in better agreement with the uncorrected values than with the exchange corrected theoretical values (i.e., they do not confirm the exchange correction of the K electron capture probability given by Bahcall). (auth)

39625 NEUTRON RADIATIVE CAPTURE IN Cu. Weigmann, H.; Winter, J. (EURATOM, Geel, Belg.). Z. Phys., 213: 411-19(1968).

Radiative neutron capture in natural Cu was studied in the neutron energy range from 200 eV to 16.5 keV. An area analysis of the data yields information on resonance parameters: For large resonances ($\Gamma_n \gg \Gamma_\gamma$) with known isotopic assignments values of Γ_γ or, if the spin of the resonance is unknown, $2g\Gamma_\gamma$ are obtained. In some cases, it was possible to assign the spin of the resonance from the measured $2g\Gamma_\gamma$ assuming a fairly constant radiation width. For a number of small resonances ($\Gamma_n \ll \Gamma_\gamma$) with unknown isotopic assignment, values of $4ag\Gamma_n$(a = isotopic abundance) were determined. The distribution of these values, including those of the stronger resonances known from literature, shows an excess of small widths which is attributed to p-wave levels. From this, the p-wave neutron strength function for natural Cu is estimated to be $S_1 = 0.30 \times 10^{-4}$. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 37781, 38149, 39296, 39552, 39575, 39594, 39602, 39606, 39701, 39702, 39707, 39710, and 39712.

39626 (ANU-P-401) SPECTROSCOPIC FACTORS FROM $^{208}Pb(d,p)^{209}Pb$ AT 8.00 MeV. Crawley, G. M.; Rao, B. V. Narasimha; Powell, D. L. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1967]. 19p. Dep.

The reaction $^{208}Pb(d,p)^{209}Pb$ was studied in the region below the Coulomb barrier in order to investigate the accuracy with which spectroscopic factors can be obtained from this process. Both distorted-wave and analytic calculations are discussed. The dependence of the spectroscopic factors on the geometry of the bound-state well leads to a value of 6.06 F for the root-mean-square radius of the nuclear potential. This is rather larger than the value obtained from electron scattering measurements. (auth)

39627 (BNL-50082, pp 19-24) NATIONAL NEUTRON CROSS SECTION CENTER. Pearlstein, S. (Brookhaven National Lab., Upton; N. Y.).

The activities of the center are summarized. Recommended values of the thermal neutron capture and fission cross sections and resonance integrals of ^{243}Am, ^{249}Bk, ^{250}Cf, ^{251}Cf, ^{252}Cf, ^{253}Cf, ^{254}Cf, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, and ^{242}Pu, which are based on a systematic treatment of available data, are presented. The random matrix theory of nuclear cross-section fluctuations was extended to include the possibility of time reversal violation in nuclear forces. Optical-model parameters that provide a good fit to the cross sections of ^{206}Pb, ^{207}Pb, and ^{208}Pb at 1 MeV were obtained. Resonance parameters for 46 resonances of Ho below 235 eV were used in fitting total cross section data on Ho to a Breit–Wigner multilevel scattering and single-level absorption formula. (D.C.W.)

39628 (CONF-670970, pp 117-38) ^3He INDUCED REACTIONS AT THE INS CYCLOTRON. Ishimatsu, T. (Tokyo Univ., Japan).

The results of an investigation of the (^3He,d) reaction on ^{24}Mg, ^{45}Sc, ^{116}Sn, ^{118}Sn, and ^{120}Sn are presented. Angular distributions and distorted-wave fits are shown, and transition strengths are given. Spectroscopic amplitudes and factors for the lowest-lying states in ^{117}Sb, ^{119}Sb, and ^{121}Sb are also included. (D.C.W.)

39629 (CONF-670970–, pp 229-42) THE (^3He,d) REACTION FOLLOWED BY PROTON EMISSION. Yavin, A. I.; Hoffswell, R. A.; Jamnik, D.; Noweir, T. M. (Univ. of Illinois, Urbana).

A method of studying proton-unstable regions of nuclei is proposed; and the results of an investigation of the (^3He,d) reaction, accompanied by proton emission, on ^{12}C, ^{16}O, ^{90}Zr, ^{91}Zr, and ^{92}Zr are presented. (D.C.W.)

39630 (ITF-68-7) PRIVEDENIE VEROYATNOSTI ELEKTRICHESKIKH KVADRUPOL'NYKH PEREKHODOV V CHETNO-CHETNYKH DEFORMIROVANNYKH ATOMNYKH YADRAKH. (The Reduced Probabilities of Electric Quadrupole Transitions in Even-Even Deformed Atomic Nuclei). Begzhanov, R. B.; Belen'kii, V. M.; Radovitskii, S. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 74p. (In Russian). Dep.

In the framework of the well-known phenomenological theories of the atomic nucleus, the reduced probabilities of electric quadrupole transitions from the levels of the first anomalous rotational band of even-even nuclei are calculated. The results obtained are represented by a number of tables and graphs and are compared with experiment. (auth)

39631 (JINR-E6-3906) ANGULAR CORRELATIONS OF GAMMA CASCADES IN ^{155}Gd. Hrynkiewicz, A. Z.; Kisielewski, J.; Stachura, Z.; Styczen, J.; Szawlowski, M.; Walus, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 8p. Dep.

Angular correlations measurements, with Ge(Li) and NaI(Tl) detectors working in coincidence, were performed for several gamma cascades present in the decay of ^{155}Tb. Results obtained for the 86.6 keV and 105.3 keV excited states in ^{155}Gd corroborate the previous spin assignments. For the states at 235.2, 266.6, 367.7, and 427.3 keV, the analysis of the angular correlation coefficients for the corresponding cascades leads to the spin values ⅜ (7/2), ½ (½, 5/2), and (3/2, 7/2), respectively. (auth)

39632 (JINR-P7-3835) ATTEMPT TO OBSERVE α-DECAY OF ^{260}Ku. Donets, E. D.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 14p. (In Russian). Dep.

Experiments on the search for the α decay of the ^{260}Ku isotope

are described. The reaction $^{242}Pu(^{22}Ne,4n)^{260}Ku$ was used to synthesize ^{260}Ku. This isotope was identified by the method of registration of the α decay on daughter products. The experimental results give an upper limit of the cross section of about 2×10^{-34} cm^2. $\sigma(E)$ is given for the reaction $^{242}Pu(^{22}Ne,\sigma 4n;^{256}102$. (auth)

39633 (LA–3958) A STUDY OF THE (t,p) REACTION ON $^{90\ 92\ 94\ 96}Zr$ AND $^{122\ 124}Sn$. Beery, Jerome G. (Los Alamos Scientific Lab., N. Mex.). Apr. 1, 1968. Contract W-7405-eng-36. 110p. Dep. CFSTI.

A study was made of the (t,p) reaction on targets of ^{90}Zr, ^{92}Zr, ^{94}Zr, ^{96}Zr, ^{122}Sn and ^{124}Sn. The purpose of the study was to investigate the nuclear energy levels that are populated by putting two neutrons into a target nucleus. The targets were bombarded with 20-MeV tritons from the Los Alamos tandem Van de Graaff facility. Protons were detected with a solid-state counter telescope, and the data were recorded with an on-line digital computer. Energy spectra were taken for each of the targets utilizing a magnetic spectrometer in order to obtain excitation energies with an accuracy of ±10 keV. The zirconium data are analyzed with a distorted-wave Born-approximation calculation, and relative spectroscopic strengths are obtained. The energy-level positions and strengths are compared to a nuclear structure calculation. (auth)

39634 (N–68–15328) EXCITED STATES OF ^{128}Xe. Julian, Glenn M.; Jha, S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 19p. (NASA-TN-D-4305). CFSTI.

Gamma rays accompanying the decay of 25-min ^{128}I and 3-min ^{126}Cs were studied with 8- and 30-cubic centimeter lithium-drifted germanium spectrometers. Coincidences between gamma rays were studied using two 7.6 by 7.6 centimeter thallium-activated sodium iodide scintillators. A level scheme of ^{128}Xe was constructed with levels at 443.2 (2^+); 969.6 (2^+); 1583.1 (0^+, 1^+, 2^+); 2275.2; 2484.3; 2600.5; 2841.1; and 2862.8 keV. According to the hydrodynamical model, the near-spherical even–even nucleus ^{128}Xe could be expected to have a close-lying $0^+ = 2^+ - 4^+$ "vibrational triplet" at about twice the energy of the first excited state. Population of the 0^+ and 2^+ members of such a triplet would be allowed in the decay of 1^+ ^{128}I and 1^+ ^{126}Cs. A 2^+ level of ^{128}Xe at about twice the energy of the first excited state had been found in previous investigations. In the present study a search was made for the predicted 0^+ triplet member. No evidence was found for the existence of such a level. (auth) (STAR)

39635 (NYO–3938–1) STUDIES OF NUCLEAR FISSION, LOW-ENERGY NUCLEAR REACTIONS, TRANSURANIC NUCLEI, AND GEO- AND COSMOCHEMISTRY. Progress Report, September 1, 1967–June 1, 1968. Huizenga, John R. (Rochester Univ., N. Y. Dept. of Chemistry). Contract AT(30-1)-3938. 29p. Dep. CFSTI.

The determination of nuclear level densities from excitation functions of isolated levels was investigated using the reactions $^{59}Co(p,\alpha)^{56}Fe$, $^{56}Fe(\alpha,p)^{59}Co$, $^{55}Mn(p,\alpha)^{52}Cr$, and $^{62}Ni(p,\alpha)^{59}Co$. The [743↑] Nilsson configuration in ^{237}U was identified by a study of the reaction $^{238}U(^3He,\alpha)^{237}U$. Transition states in odd-A nuclei were investigated by measuring fission-fragment angular distributions and cross sections for neutron fission of ^{232}Th as a function of neutron energy and by measuring fission-fragment angular distributions for neutron fission of ^{234}U. An interpretation of the fission-fragment angular distributions in deuteron fission of ^{209}Bi at moderately large excitation energies was proposed. (D.C.W.)

39636 (ORO–3398–12) RESEARCH AND OPERATION OF THE TEXAS A AND M VARIABLE ENERGY CYCLOTRON. Progress Report, July 1, 1968. (Texas Agricultural and Mechanical Univ., College Station). Contract AT(40-1)-3398. 28p. Dep. CFSTI.

The analysis of high-resolution γ-ray and conversion-electron spectra in the decay of 15-hr ^{186}Ir continued; multipolarities were assigned to 145 transitions among 40 levels proposed for ^{186}Os. In addition to the well-established ground-state and K = 2 rotational bands, a second K = 0 rotational band is proposed with the bandhead at 1530 keV. Preliminary investigations of systems for studying nucleon interactions in three-body configurations were performed. Research programs dealing with nucleon-nucleon scattering, (^{3}He,d) and (d,^{3}He) reactions, Co sources, heavy ion penetration, angular momentum effects in nuclear reactions, fission fragments, activation analysis, and radiotherapy are also outlined. The cyclotron development program is summarized. (D.C.W.)

39637 (RPI–328–123, pp 1–17) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The average capture cross sections of W, ^{182}W, ^{183}W, ^{184}W, and ^{186}W in the energy range from 1 to 100 keV were determined. The p-wave strength functions for ^{56}Fe and ^{58}Ni were extracted from capture data, and the radiative width of the 4.6-keV resonance in ^{62}Ni was determined. The total cross section of ^{147}Pm was determined by transmission measurements on four $^{147}Pm_2O_3$ samples over the energy range from 0.008 to 200 eV; neutron resonance parameters were obtained for energies up to ≈20 eV. (D.C.W.)

39638 (UCRL–17989, pp 1–41) NUCLEAR SPECTROSCOPY. (California Univ., Berkeley. Lawrence Radiation Lab.).

The α decay of ^{237}Np was investigated; a partial level scheme for ^{233}Pa was proposed. A nondestructive method for determination of F by ^{3}He activation was developed; excitation functions for the reactions $^{19}F(^3He,2p)^{20}F$ and $^{19}F(^3He\text{-}3,\alpha)^{18}F$ were measured. Excitation functions for nuclear reactions induced in ^{16}O by 3- to 20-MeV $^3He^{2+}$ ions were also measured. The energy levels of ^{235}U were investigated using Coulomb excitation with α particles, ^{16}O ions, and ^{40}Ar ions. Energy levels in ^{154}Dy were studied using ^{154}Ho decay and the reaction $^{139}La(^{19}F,4n)^{154}Dy$. Collective levels in $^{128,130,132,134,136}Ce$ were investigated using (^{20}Ne,4n) reactions on $^{110,112,114,116}Cd$ and (^{16}O,4n) reactions on $^{116,118,120,122,124}Sn$. The systematics of energy levels of even nuclei were analyzed. Gamma angular distributions, γ spectra, and proton spectra from proton inelastic scattering by ^{54}Fe were measured in preliminary experiments on the spins of excited states in ^{54}Fe. (D.C.W.)

39639 (UCRL–17989, pp 43–99) NUCLEAR REACTIONS AND SCATTERING. (California Univ., Berkeley. Lawrence Radiation Lab.).

The emission of α particles in the bombardment of ^{197}Au, Pb, and Ta with α particles at 42, 50, 65, and 90 MeV was investigated. A comparison of ^{3}He and α-particle scattering by ^{24}Mg in the DWBA and optical-model formalisms was made; transition strengths for several levels are presented. Angular distributions and excitation functions for elastic and inelastic scattering of α particles by ^{12}C, ^{24}Mg, and ^{58}Ni at 24 to 40 MeV were measured; and the excitation of unnatural-parity states in ^{24}Mg, ^{20}Ne, and ^{16}O by α inelastic scattering was investigated. The energy levels of ^{207}Pb and ^{207}Tl were studied using the reactions $^{208}Pb(d,t)^{207}Pb$ and $^{208}Pb(d,He^3)^{207}Tl$ at 50 MeV. A search for high-spin states with $(g_{9/2})^3_{13/2}$ configurations in nuclei with $54 \leq A \leq 70$ was made using (α,d) and (α,t) reactions on ^{52}Cr, ^{59}Co, ^{63}Cu, ^{54}Fe, ^{56}Fe, ^{58}Ni, ^{60}Ni, ^{62}Ni, ^{64}Zn, ^{66}Zn, and ^{68}Zn. Low-lying states with $T = \frac{3}{2}$ were observed in ^{11}B and ^{11}C using the reactions $^{13}C(p,t)^{11}C$ and $^{13}C(p,He^3)^{11}B$; the decay modes of the states were investigated. (D.C.W.)

39640 (UCRL–17989, pp 127–57) FISSION. (California Univ., Berkeley. Lawrence Radiation Lab.).

Coincidence measurements (x-γ) were made on the fission products from spontaneous fission of ^{252}Cf; a four-dimensional study of conversion electrons and K x rays from the primary fission fragments was also carried out. The relative stability of superheavy nuclei, particularly $Z > 110$, was investigated theoretically, as were shell effects in nuclear level densities. First-chance fission probabilities for ^{187}Os and ^{188}Os were determined through measurements of the cross sections for α-induced fission of ^{182}W, ^{183}W, and ^{184}W at incident α energies of 35 to 120 MeV. Pairing effects at the fission saddle points of the compound nuclei ^{210}Po and ^{211}Po in α-induced fission of ^{206}Pb and ^{207}Pb were also investigated. A search for elements near Z = 114 was made using ^{40}Ar reactions with ^{244}Cm and ^{248}Cm. (D.C.W.)

39641 TOTAL ABSORPTION METHOD FOR INVESTIGATIONS OF ELECTRON CAPTURE AND THE K-CAPTURE PROBABILITY OF ^{139}Ce. Vatai, E.; Hohmuth, K. ATOMKI (At. Kut. Intez.) Kozlem., 10: 27–32(Apr. 1968).

A total absorption method utilizing a 4π CsI(Tl) scintillation spectrometer to detect the x rays and Auger electrons following electron capture is described. The necessary source and crystal thicknesses are discussed. The K-capture probability of ^{139}Ce was measured to be 0.69 ± 0.02. (auth)

39642 THE STUDY OF THE GROUND-STATE ROTATIONAL BANDS IN ^{233}U AND ^{235}U BY THE INELASTIC SCATTERING OF DEUTERONS. Sterba, F. (Charles Univ., Prague). Czech. J. Phys., 18: 900–9(1968).

The ground-state rotational bands in the odd isotopes ^{233}U and ^{235}U were studied by the inelastic scattering of 13.1-MeV deuterons. Seven members of these bands were seen in both nuclei. By fitting the experimental energies of the levels to the relation $E(I) = A[I(I+1) + B[I(I+1)]^2$, the parameters A and B were determined. Their values and the upper limits of the quadrupole reduced transition probabilities determined from the cross sections were: U 233: A = (5.93 ± 0.10) keV, B = (–0.002 ± 0.001) keV, $B(E2, 5/2 \rightarrow 7/2) = (6.51 \pm 0.66) \times 10^{-48}$ e^{2}cm^4, $B(E2, 5/2 \rightarrow 9/2) = (2.80 \pm 0.37) \times 10^{-48}$ e^2 cm^4. U 235: A = (5.36 ± 0.04) keV, B = (–0.0017 ± 0.0004) keV, $B(E2, 7/2 \rightarrow 9/2) = (8.05 \pm 0.71) \times 10^{-48}$ e^2 cm^4, $B(E2, 7/2 \rightarrow 11/2) = (2.17 \pm 0.39) \times 10^{-48}$ e^2 cm^4. (auth)

39643 MEAN NUMBER OF INSTANTANEOUS NEUTRONS AT THE FISSION OF ^{235}U AND ^{232}Th BY 3.3 MeV NEUTRONS. Prokhorova, L. I.; Smirenkin, G. N. Yadern. Fiz., 7: 961-6 (May 1968). (In Russian).

The results of relative measurements of the mean number of prompt neutrons $\bar{\nu}$ from ^{232}Th in the energy range 1.5 to 3.3 MeV and $\bar{\nu}$ from ^{235}U in the energy range 0.4 to 3.3 MeV are presented. To measure $\bar{\nu}$, a set of 36 $B^{10}F_3$ counters was used. Fission events were registered by a multilayer ionization chamber. The accuracy of the values is ~1.5% for ^{235}U and ~2.5% for ^{232}Th. $\bar{\nu}$ was measured by comparison with the thermal value of $\bar{\nu}$ for ^{235}U. (auth)

39644 ON DETECTION OF THE (n,γf) REACTION. Vorotnikov, P. E.; Otroshchenko, G. A. Yadern. Fiz., 7: 967-9(May 1968). (In Russian).

Conclusions about the detection of the (n,γf) reaction at the fission of ^{238}Pu by slow neutrons are shown to be wrong. Effective numbers of the fission channels per spin state of the compound nucleus at the slow neutron fission of the nuclei ^{235}U, ^{238}Pu, and ^{239}Pu are approximately identical and are equal to 4.5 ± 1.2. (auth)

39645 KINETIC ENERGIES OF PAIR FRAGMENTS OF THE ^{235}U PHOTOFISSION AT $E_{\gamma max}$ = 25 MeV. Petrzhak, K. A.; Tutin, G. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 970-6(May 1968). (In Russian).

Using an ionization chamber, kinetic energy distributions of pair fragments from ^{235}U photofission at $E_{\gamma\ max}$ = 25 MeV are measured. The most probable summary kinetic energy of the fragments is 165 ± 4 MeV. Summary kinetic energy spectra for different ratios of fragment masses are obtained. The results obtained are in agreement with the hypothesis of two distinct fission modes. (auth)

39646 PROPERTIES OF SOME ISOTOPES OF THE ELEMENTS 102 AND 103. Flerov, G. N.; Akapev, G. N.; Demin, A. G.; Druin, V. A.; Lobanov, Yu. V.; Fefilov, B. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 977-83 (May 1968). (In Russian).

In the reactions $^{238}U(^{22}Ne,5n)^{255}No$ and $^{239}Pu(^{18}O,5n)^{252}No$, the properties of the α decay of the isotopes ^{255}No (E_α = 8.08 ± 0.03 MeV; $T_{\frac{1}{2}}$ = 3.0 ± 0.2 min) and ^{252}No (E_α = 8.41 ± 0.03 MeV; $T_{\frac{1}{2}}$ ≈ 3 sec) were investigated; the results are in good agreement with previously established properties. The data on fragments of spontaneous fission of products of the reaction $^{238}U + {}^{18}O$ are presented. It is concluded that the partial period of spontaneous fission of ^{252}No according to the data by A. Ghiorso et al. ^{256}Lw should be considered as a lower limit. Data on the properties of ^{256}Lw (E_α = 8.35 to 8.55 MeV; $T_{\frac{1}{2}}$ ≈ 0.4 min) are also included. (auth)

39647 ANALYSIS OF SOME NUCLEAR PROPERTIES ACCORDING TO THE DONNER AND GREINER MODEL. Plastino, A. (Univ. Nacional, La Plata); Abecasis, S. M.; Bosch, H. E. Nuovo Cim., 56B: 38-46(July 11, 1968).

Static and dynamical properties of even-mass heavy deformed nuclei are calculated within the framework of the Donner and Greiner model. Theoretical predictions are in fair agreement with experiment as well as with results obtained using a microscopic description. (auth)

39648 ATLAS OF γ-RAY SPECTRA FROM RADIATIVE CAPTURE OF THERMAL NEUTRONS. Groshev, L. V.; Lutsenko, V. N.; Demidov, A. M.; Pelekhov, V. I. International Series of Monographs on Nuclear Energy. Division IV. Isotopes and Radiation. Volume I. New York, Pergamon Press, [1967]. 202p. $20.00.

Translated from the Russian by J. B. Sykes.

A compilation of information on the spectra of γ rays emitted in thermal neutron capture is presented. Graphs of observed and corrected spectra are included; data obtained before January 1958 on the γ line energies and intensities are tabulated. Gamma transition diagrams for the nuclei of certain isotopes are also included. (97 references). (D.C.W.)

39649 SCATTERING OF 34.4-MeV ALPHA PARTICLES BY THE TIN ISOTOPES. Kumabe, Isao; Ogata, Hiroshi; Kim, Tong-hyuk; Inoue, Makoto; Okuma, Yasuhiko; Matoba, Masaru (Kyoto Univ.). J. Phys. Soc. Jap., 25: 14-20(July 1968).

The angular distributions of alpha particles elastically and inelastically scattered by ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, and ^{120}Sn were measured at 34.4 MeV. The angular distributions of the prominent groups corresponding to the quadrupole and octupole excitations were fitted with the results of DWBA predictions. In these calculations Coulomb excitation was found to be important for these nuclei. The extracted deformation parameters β_2 and β_3 for the even tin isotopes are in good agreement with those obtained by other workers. Both the shapes and magnitudes of the angular distributions of the groups corresponding to the quadrupole and octupole excitations for the odd-mass tin isotopes were found to be very similar to those for the even tin isotopes. Possible hexadecapole excitations are discussed. (auth)

39650 ISOMERIC TRANSITION OF ^{179}Hf. Katoh, Toshio (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 51-3(July 1968).

Decay of $^{179\,m}Hf$ was investigated by a well-type scintillation counter. The half-lives of peaks which were seen in sum spectra were determined to be 19 ± 2 sec. The K internal conversion coefficient of the 161-keV transition was also determined as 17 ± 2. The E4 mixing ratio to the M3 component was, therefore, 0.14 ± 0.14. (auth)

39651 INVESTIGATION OF SPACE-DEPENDENT FAST FISSION RATIOS AND MEASUREMENTS OF FISSION-FRAGMENT RECOIL RANGES IN ALUMINUM. Osias, David Justin. Ithaca, N. Y., Cornell Univ., 1967. 147p.

Thesis.

Space-dependent values of δ_{28} (^{238}U to ^{235}U fission ratio) are measured in two cores of the 2.1% enriched UO_2, light water moderated critical facility at Cornell University. Measurements are also made in an isolated 0.600-in.-diameter fuel rod in a purely thermal flux. Heterogeneous finite lattice calculations are made with different cross section sets to investigate cross section uncertainties. The ^{238}U cross sections recommended by the Atomic Weapons Research Establishment produce agreement of the calculations with the measurement of δ_{28} in a single fuel rod (δ_{28} = 0.0150 ± .0003), and because σ_{inel} has little effect on this calculated value, the agreement indicates an integral accuracy for σ_f of about 2%, which is the accuracy of the isolated rod experiment. For the finite lattice calculations, the core region is taken to be a homogenized cylinder with the space-dependent fast flux at each of 30 energy points approximated by a fourth-order even polynomial, using the neutron transport method of K. B. Cady and M. Clark, Jr. Two formulas for correcting anisotropic scattering result in high and low limits for δ_{28}. Energy-dependent disadvantage factors for the 30 energy points, used for obtaining homogenized cross sections, are obtained from a multi-energy escape probability calculations for the infinite lattice cell. The calculated intensive (infinite lattice) values of δ_{28} are substantially higher (about 15% to 20%) than the extensive values calculated for the finite lattices, showing a significant leakage effect. The two experimental points for the 1.5/1 core suggest that the average σ_f recommended by AWRE is accurate to about 2%. For the 3/1 core, the theory and experiment (about 1% experimental error) show a small unexplained discrepancy. The assumed uncertainty of σ_{inel} and other cross sections (obtained by subjectively surveying experimental data for cross sections) is not large enough to account for the 3 to 4% discrepancy. The experimental data are obtained by using a lithium-drifted germanium detector to measure the activities of the 1.6-MeV ^{140}La photopeak in highly depleted (23 ppM ^{235}U) and in 2.1% enriched UO_2 wafers. The precision of this method is believed to be better than that obtained from threshold gamma-ray counting, partly because no measurement with a double fission chamber of the time-dependent ratio of ^{238}U to ^{235}U fission product activities is needed. There is, however, a systematic uncertainty of about ±2% in the ^{140}La yield from fission of ^{238}U, and this 2% must be added to the standard errors quoted here for the δ_{28} measurements. A study is made of the gross fission product gamma-ray spectrum to discover any better means of measuring fission events. None is found, but it is discovered that gamma-ray spectra from the germanium detector can be used for quantitative measurements of many fission products with no chemical separations. A technique for computerized evaluation of complex gamma-ray spectra is developed. By using the computer program to analyze the spectra obtained with the germanium detector, measurements are made of the mean recoil ranges in aluminum of 19 high yield fission fragments from thermal fission of ^{235}U. Ranges are calculated from the relative numbers of fission fragments stopping in each of four aluminum catcher foils (1.204 mg/cm²) placed next to a thin film of ^{235}U. Precision varies from 0.2 to 1.5%, with most measurements having standard deviations between 0.3 and 0.8%. Previous experimenters report comparable accuracy. However, the present experiment involves less effort, and provides ranges for many atomic masses which had not been measured previously. (Diss. Abstr.)

39652 THE ^{233}U FISSION AND CAPTURE CROSS SECTIONS AND THEIR ANALYSIS AT LOW ENERGIES. Bergen, Delmar Wesley. Albuquerque, N. Mex., Univ. of New Mexico, 1967. 78p.

Thesis.

The ^{233}U fission and capture cross sections were measured using a nuclear-device neutron source and time-of-flight tech-

niques. Cross-section data are presented from 20 to 10^6 eV for fission and from 20 to 63 eV for fission + capture. The resonance region (20 to 63 eV) was fitted with both a single-level function consisting of a sum of Breit-Wigner levels and the Reich and Moore multilevel function based on R-matrix theory. The resulting resonance parameters are listed and discussed. In order to establish the validity of the resonance parameters derived from the multilevel fit, a study is presented of the cross section derived from two and three hypothetical resonances under various conditions and of the cross sections obtained from randomly generated resonances. (Diss. Abstr.)

39653 POLARIZATION STUDIES OF ISOBARIC ANALOGUE RESONANCES. Fiarman, Sidney. New Brunswick, N. J., Rutgers–The State Univ., 1967. 182p.
Thesis.

The polarization of elastically scattered protons from ^{90}Zr, ^{144}Sm, and ^{204,206,208}Pb at energies near isobaric analogue resonances was measured. The analysis of such measurements led to nuclear spin assignments to the low-lying states of ^{91}Zr, ^{145}Sm, and ^{205,207,209}Pb whose analogue states in ^{91}Nb, ^{145}Eu, and ^{205,207,209}Bi produced large resonances in elastic proton scattering. In addition to spin assignments, the polarization measurements of ^{144}Sm(p,p) and ^{204}Pb(p,p) produced a more accurate set of resonance parameters and a better understanding of the above nuclear states. For the case of the 1.62-MeV level in ^{145}Sm, a systematic approach to parameter extraction led to an unambiguous assignment of $\frac{1}{2}^-$, while the polarization data of ^{204}Pb(p,p) near 15 MeV indicated a $\frac{7}{2}^+$ state in this region. Both of these spin assignments are new. The ground state of ^{209}Pb, a single-particle state with a doubly magic core, is unambiguously assigned a spin of $\frac{9}{2}^+$. (Diss. Abstr.)

39654 INVESTIGATIONS OF NUCLEAR STATES AND TRANSITIONS BY MEANS OF PRECISION ELECTRON AND GAMMA-RAY SPECTROSCOPY. Pettersson, Harry. Abstracts of Uppsala Dissertations in Science, No. 110. Uppsala, Uppsala Univ., 1968. 12p.
Thesis.

A review is given of 12 published papers on the following subjects: an automatically operating double-focusing beta-ray spectrometer; decay of ^{55}Co; decay of ^{62}Zn; positrons and conversion electrons from the ^{90}Mo decay; decay of ^{90}Nb; negatrons and conversion electrons from the decay of ^{96}Nb; conversion coefficients of transitions in ^{111}Cd; anomalous interval conversion of the 212-keV transition in ^{121}Te; decay of ^{140}La; the monoenergetic positron line in the decay of ^{152}Eu; establishment of an excited state at 1.64 keV in ^{193}Pt; and an internal conversion study of the decay of ^{193}Au. (Sweden)

39655 PRECISION ELECTRON SPECTROSCOPY FOR STUDIES OF NUCLEAR AND ATOMIC ENERGY LEVELS. Karlsson, Sven-Erik. Abstracts of Uppsala Dissertations in Science, No. 99. Uppsala, Uppsala Univ., 1967. 12p.
Thesis.

A review is given of 12 published papers dealing with the following subjects: a 50-cm double focusing spectrometer of the current sheet type; array detectors and an extended source used in a double-focusing beta spectrometer; decay of ^{105}Rh; transitions following decay of ^{166}Dy; decay of ^{191}Au and level scheme of ^{919}Pt; decay of ^{140}La; low-energy internal conversion spectrum of ^{182}W from decay of ^{182}Ta; L subshell ratios in some pure E2 transitions; precision measurements of the 296-keV and 316-keV transitions in ^{192}Pt; determination of L subshell ratios of pure M1 transitions; extension of the photoelectron method to elements of low atomic number; and electron binding energies in Pt. (Sweden)

39656 SPONTANEOUS FISSION-PRODUCED STRONTIUM ISOTOPES IN URANIUM MINERALS AND SALTS. Arino, H.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 30: 677-83(May 1968).

^{89}Sr and ^{90}Sr were separated from kilogram quantities of 17-year-old depleted uranium ($^{238}UO_3$), 14- to 15-yr-old natural uranyl nitrate and about 600-million-year-old Katanga pitchblende, exhaustively purified and counted. Assuming that the ^{90}Sr in the depleted uranium was formed by spontaneous fission only, the ^{238}U spontaneous fission yield for mass chain 90 was calculated to be 5.9 ± 0.6%. A value of 3.3 ± 0.3% was obtained for the ^{89}Sr yield. About 20% of all the fission events taking place in pitchblende was estimated to be neutron-induced fission of ^{235}U, and 80% ^{238}U spontaneous fission. The data indicated that the ratio of induced fission vs spontaneous fission in non-irradiated natural uranyl nitrate hexahydrate can be as high as 0.3 to 0.4. (auth) (UK)

39657 EXPERIMENTAL DECAY-SCHEME STUDIES OF ODD-A DEFORMED NUCLEI. Blichert-Toft, P. H. Goteborg, Chalmers Tekniska Hogskola, 1968. 14p.
Thesis.

A review is given on 6 published papers on the following subjects: an improved experimental method for internal conversion coefficient measurements; decay of ^{189}Re to ^{189}Os; decay of ^{191}Pt (3.0d) to ^{191}Ir; decay of ^{153}Sm(47 hr) to ^{153}Eu; decay of ^{155}Tb(5.6d) and ^{155}Eu (1.81 yr) to levels in ^{155}Gd; and decay of ^{155}Dy(10.2h) to ^{155}Tb and ^{157}Dy(8.06 hr) to ^{157}Tb. (Sweden)

39658 NUCLEAR TRANSITION PROPERTIES STUDIED BY DIRECTIONAL CORRELATION METHODS. Vukanovic, Radomir. Abstracts of Uppsala Dissertations in Science, No. 113. Uppsala, Uppsala Univ., 1968. 11p.
Thesis.

A review is given of 8 published papers on the following subjects: an electron directional correlation spectrometer; decay dependent background signals in a magnetic electron spectrometer; conversion coefficients and particle parameters in ^{207}Pb; determination of the multipole mixture of the K-forbidden 1095-keV transition in ^{172}Yb; directional correlation study of interband transitions in ^{172}Tb; multipole mixture of the 793-keV $2^+ - 2^+$ transition in ^{184}W; conversion electron-gamma directional correlation measurements on ^{192}Pt; and search for two-quantum decay by double internal conversion in the decay of ^{116m}In. (Sweden)

39659 PROPERTIES OF EXCITED ATOMIC NUCLEI AND HYPERFINE INTERACTIONS FROM ANGULAR CORRELATION EXPERIMENTS. Johansson, Kurt. Abstracts of Uppsala Dissertations in Science, No. 111. Uppsala, Uppsala Univ., 1968. 8p.
Thesis.

A review is given on 11 published papers on the following subjects: the g-factor of the 1st excited state in ^{108}Pd; magnetic moment of the lowest 2^+ vibrational state in ^{122}Te; the nuclear g-factor of the 1301-keV 4^+ level in ^{144}Nd; the magnetic moment of the $\frac{9}{2}^+$ rotational state in ^{175}Lu; the magnetic moment of the 139-keV level in ^{193}Ir and the magnetic hyperfine interaction in an Fe–Ir alloy; the magnetic moment of the $\frac{1}{2}^+$ state in ^{203}Tl and the question of core excitations; possible core-polarization effects in the magnetic moments of states in ^{207}Pb; the nuclear magnetic moment of the 3.2-MeV state in ^{208}Pb; measurements of combined magnetic and electric perturbations on angular correlations of gamma rays from polycrystalline sources; temperature dependence of the magnetic hyperfine field at palladium in iron; and an instrument for study of moments of excited nuclear states by angular correlation methods. (Sweden)

39660 NUCLEAR PROPERTIES FROM ANGULAR CORRELATIONS AND SPECTROSCOPIC DECAY STUDIES. Gustafsson, Sven. Abstracts of Uppsala Dissertations in Science, No. 83. Abstracts of Uppsala Dissertations in Science, No. 83. Uppsala, Uppsala Univ., 1967. 15p.
Thesis.

A review is given of 9 published papers. From measurements of various nuclear properties, it was possible to identify low-energy spectra for nuclei near major closed shells as due to motion of a single particle in an effective field, the regions of application being $A \leq 20$, $A \sim 40$, and $A \sim 208$. For nuclei very far from closed shells were found appreciable equilibrium deformation, and the interpretation of related level schemes in terms of collective rotations of the nucleons was successful. The principal regions are then: $20 < A < 30$; $150 < A < 190$; $A < 220$. Further, for large regions ($60 < A < 150$; $190 < A < 220$), certain data were interpretable on the basis of the vibrational collective model for spherical nuclei, viz. the nucleus is then assumed to execute collective oscillations about its equilibrium shape. The methods provided by nuclear spectroscopy to study electromagnetic radiation from nuclei were of decisive importance in obtaining knowledge about nuclear structure. A natural approach to the study of a decay scheme is the determination of the spectra of the internal conversion electrons and the gamma rays. (Sweden)

39661 STUDIES OF SOME NUCLEAR TRANSITIONS BY MEANS OF NUCLEAR SPECTROSCOPY METHODS. Zupancic, Mladen. Abstracts of Uppsala Dissertations in Science, No. 114. Uppsala, Uppsala Univ., 1968. 7p.
Thesis.

A review is given of 8 published papers on the following subjects: internal conversion spectrum of ^{192}Pt and ^{192}Os; external conversion spectrum of ^{192}Pt gamma rays from the decay of ^{192}Ir; level scheme of ^{192}Os; beta decay of ^{147}Nd; decay-dependent background signals in a magnetic electron spectrometer; determination of the multipole mixture of the K-forbidden 1095-keV transition in ^{172}Yb; directional correlation study of interband transitions in ^{172}Yb; and multipole mixture of the 793 $2^+ - 2^+$ transition in ^{184}W. (Sweden)

39662 MASS-SPECTROMETRIC MEASUREMENTS OF THE NEUTRON CAPTURE CROSS SECTIONS OF ^{142}Nd, ^{143}Nd, ^{144}Nd, AND ^{145}Nd FOR REACTOR AND MAXWELLIAN NEUTRONS. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establish-

ment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 897-905(May 1968). (AERE-R-5520).

Enriched samples of ^{142}Nd, ^{143}Nd, ^{144}Nd, and ^{145}Nd were irradiated for six months in known neutron spectra in the core of the PLUTO reactor. The neutron capture cross sections were obtained from mass analyses of the samples before and after irradiation. In addition, values of Westcott's s_0/g for ^{142}Nd and ^{145}Nd were found to be -2.05 ± 0.69 and 6.4 ± 0.9, respectively. (auth) (UK)

39663 ON THE CALCULATION OF THE AMOUNTS OF FISSION, NEUTRON CAPTURE, DECAY, AND OTHER PRODUCTS, FORMED DURING NEUTRON IRRADIATION OF FISSILE MATERIALS. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 907-17(May 1968).

A method is described of writing down the explicit solutions of the differential equations of growth and decay of individual nuclides formed during the neutron irradiation of fissile materials. The solutions are written in a very compact form by means of functions defined by a recursion relation, and they are in a form which can be written as Fortran routines directly. The method is easily applied to the growth and decay of the products of neutron capture, e.g., transuranic elements. (auth) (UK)

39664 SPIN-QUADRUPOLE FORCES AND COLLECTIVE STATES OF DEFORMED NUCLEI. II. THE 2^+ STATES. Pyatov, N. I.; Chernyi, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1689-95(Oct. 1967). (In Russian).

The influence of spin-quadrupole interactions on the properties of 2^+ vibrational states was investigated. Ordinarily, the theory predicts appearance of the secondary 2^+ states on the order of 2 MeV. However, recent studies uncovered secondary 2^+ states in transuranic nuclei at 0.969 and 1.15 MeV (^{232}Th), 0.783 and 1.013 MeV (^{230}Th), and 0.926 and 1.126 MeV (^{234}U). An attempt was made to determine the effects of spin-quadrupole interactions of the properties of the lowest 2^+ states and on the structure of the 2^+ state wave functions. Data obtained indicated that spin-quadrupole interactions influence very slightly the properties of the lowest collective 2^+ states, but that the properties of the successive 2^+ states are influenced considerably. (R.V.J.)

39665 STUDIES OF ^{149}Sm LEVELS BY COULOMB EXCITATION. Bondarev, V. K.; Il'yasov, A. Z.; Lemberg, I. Kh.; Chugunov, I. N. (Ioffe Inst. of Physics and Tech., Leningrad. Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1686-8(Oct. 1967). (In Russian).

Gamma spectra from the irradiation of ^{149}Sm with $^{12}C^{4+}$ ions were recorded using a semiconductor p-i-n detector. The lifetimes and probabilities for E2 transitions in ^{149}Sm were determined. (R.V.J.)

39666 STUDIES OF THE ^{138}*Pr DECAY SCHEME. Babadzhanov, R.; Vrzal, Ya.; Gromov, K. Ya.; Liptak, Ya.; Morozov, V. A.; Mukhtasimov, F. N.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1724-33(Oct. 1967). (In Russian).

The decay scheme of ^{138*}Pr was investigated using a Ge(Li) spectrometer and a β spectrograph with a constant homogeneous magnetic field to determine the energies and relative intensities of γ and conversion-electron spectral lines, respectively. Triple (γ) (511) (511) coincidences were analyzed in order to establish the states arising from β^+ decay. The data obtained showed that the decay of the isomeric state with $T_{1/2} = 2.2$ hr leads to levels at 2216.2, 2371.8, and 2482.6 keV with quantum numbers 5^- or 5; 6 or 6^+; and 7^+, respectively. On the basis of the results, an assignment of 6^- was made for the isomeric state of ^{138}Pr. (R.V.J.)

39667 STUDIES OF ^{151}Gd RADIATIONS. Gromov, K. Ya.; Kuznetsov, V. V.; Nenov, N.; Nil'sen, O. B.; Skilbrait, O.; Fomin'ykh, V. I.; Khistov, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1716-23(Oct. 1967). (In Russian).

The decay scheme of ^{151}Gd was investigated using a six-gap toroidal β spectrometer to record conversion-electron spectra and using Ge(Li) detectors to record γ spectra from a ^{151}Gd + ^{153}Gd source. The energies and relative intensities of the conversion-electron and γ lines were determined. Conversion coefficients and multipolarities of transitions in ^{151}Eu were determined and were compared with theoretical predictions. (R.V.J.)

39668 SPINS OF THE GROUND-STATE CONFIGURATIONS $(2f_{\frac{5}{2}})^{\pm 3}$ IN ODD NUCLEI WITH A = 135 TO 151. Peker, L. K. (All-Union Scientific-Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1746-7(Oct. 1967). (In Russian).

An analysis of states with $(1f_{\frac{7}{2}})^{\pm 3}$ configurations in A = 41 to 55 nuclei and of states with $(2f_{\frac{5}{2}})^{\pm 3}$ configurations in A = 135 to 151 nuclei showed that a satisfactory description of such states can be obtained only if deformation effects are taken into account. (R.V.J.)

39669 K X-RAY γ-RAY DIRECTIONAL CORRELATION IN THE DECAY OF ^{65}Zn, ^{85}Sr, ^{113}Sn, AND ^{133}Ba. Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Phys. Lett., 27B: 215-16(July 8, 1968).

The directional correlation between the K x ray following K-capture and the succeeding nuclear gamma ray in the decay of ^{65}Zn, ^{85}Sr, ^{113}Sn, and ^{133}Ba was measured. Within the accuracy of the measurements, a zero anisotropy was observed, which is consistent with the theoretical predictions of Dolginov. (auth)

39670 RATIOS OF REDUCED PROBABILITIES OF γ-TRANSITIONS BETWEEN ROTATIONAL BANDS. Mikhailov, V. M.; Mikhailova, M. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1708-15(Oct. 1967). (In Russian).

The coupling of collective and intrinsic motions in deformed nuclei stipulates the nonconservation of the angular momentum (K) projection on the axis of nuclear symmetry. Considerations of this coupling help to verify the Alaga rules for calculating γ transition intensities and for constructing expressions for the probabilities of K-forbidden transitions. The previously developed expressions were compared with experimental data. The ratios of reduced probabilities of $\Delta K \geq \lambda$ transitions are tabulated using published data for Tb, Er, Yb, Lu, Hf, U, Np, Cm, Dy, W, Bk, Ho, Os, Th, Tm isotopes. The agreement between the theoretical and experimental data was judged by the constant ratios of parameters calculated for all transitions between the assigned rotational bands. (R.V.J.)

39671 RADIOACTIVE DETERMINATION OF TELLURIUM BY (n,2n) REACTION. Tustanovskii, V. T.; Orifkhodzhaev, U.; Starchik, L. P. (Tadzhik State Univ, Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR, 11: No. 2, 26-9(1968). (In Russian).

The nuclear characteristics of short-life products from 14-MeV neutron reactions with Te are tabulated. Gamma spectra obtained from Te activated for 5-min showed that the ^{130}Te (n,2n)^{129}Te reaction was the dominating process in inelastic interactions between fast neutrons and Te isotopes. The sensitivity of the determination of a 10-g Te specimen activated for 30 min was 5×10^{-4}%. (R.V.J.)

39672 KINETIC ENERGY VARIATIONS OF FISSION FRAGMENTS IN ^{235}U NEUTRON RESONANCES. Bochvarov, S.; Dermendzhiev, E.; Kashukeev, N. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 199-202(1968). (In Russian).

The variation of the mean kinetic energy of fission fragments in the fission of ^{235}U by resonance neutrons of 0.2 to 20 eV was investigated using a double ionization chamber with a screen grid to detect the fragments. Measurements were made with both thick (~30 μg/cm^2) and thin (~4 to 5 mg/cm^2) ^{235}U targets. The ratio of the number of fissions recorded in the thick and thin targets at each of eleven resonance energies was determined. (D.C.W.)

39673 HUNT FOR ELEMENT-126. de Closets, Francois. Sci. Avenir, No. 251, 8-15(Jan. 1968). (In French).

After the discovery of kurchatovium in 1965, Russian workers announced the production of element 105 this year. The ephemeral trans-Lw elements should be difficult to study until the region of element 126 is attained. This element is anticipated to have a longer half-life because of the attainment of magic numbers. Nuclear structure is discussed to support this contention. Methods of preparation are suggested for $^{310}M_{126}$. Bombardment with heavy nuclei is the obvious approach. At Orsay, the CEVIL accelerator is being used to test the reaction of ^{232}Th with ^{82}Kr to produce $^{310}M_{126}$ and 4 n. It is necessary to remove at least 20 electrons from Kr to attain energies of the order of 100 MeV. Design of apparatus in France to reach this goal is described, and an indication of American and Soviet procedures is given. The use of tandem Van de Graaff accelerators for acceleration of U ions for collision with each other is suggested. The lifetime of this isotope is unpredictable, but the recently announced 10-hour lifetime for ^{258}Md is a pleasant surprise in the right direction. (BBB)

39674 THE E2 + M1 DECAY OF THE 2^+ BETA-VIBRATIONAL STATE IN ^{178}Hf. Nielsen, H. L.; Nielsen, K. Bonde; Rud, N. (Univ. of Aarhus, Denmark). Phys. Lett., 27B: 150-2(June 24, 1968).

The 1183-keV transition depopulating the 2^+ beta-vibrational state in ^{178}Hf was found to be E2 + M1 with 17 ± 10% E2. The E2 branching ratios are shown to agree with theoretical predictions by Bohr and Mottelson. (auth)

39675 NOTE ON THE ENERGIES OF THE GAMMA TRANSITIONS IN ^{113}Sn DECAY. Barrette, J.; Monaro, S. (Univ., Montreal). Nucl. Instrum. Methods, 63: 235-6(Aug. 1968).

The energies of gamma rays emitted in the ^{113}Sn decay were measured with a high-resolution 30-cm^3 Ge(Li) detector. By intercomparing close-lying full-energy peaks arising from suitable calibration sources as ^{57}Co, ^{203}Hg, ^{192}Ir, and ^{68}Ge, energy values for the gamma rays present in the ^{113}Sn decay were determined as follows: 255.11 ± 0.08 and 391.75 ± 0.05 keV. Furthermore the energies of some of the γ transitions present in the decay of ^{133}Ba were remeasured and yielded values of 276.33 ± 0.05, 302.85 ± 0.05, 356.03 ± 0.05, and 383.90 ± 0.05 keV. (auth)

39676 PERTURBED ANGULAR CORRELATIONS IN ^{177}Hf. Brooker, W. H.; McMath, T. A.; Murray, J.; Cameron, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 1523-6(July 1, 1968).

Ions of ^{177}Lu were implanted in iron and nickel hosts at concentrations of about 10^{14}/cm^3. Perturbation of angular correlations in the gamma-ray cascade through the 113-keV level gives values for the internal fields on hafnium nuclei in these metals at room temperature and for this concentration of H(Fe) = −140 ± 10 kOe and H(Ni) = −60 ± 10 kOe. The rotation of the 250-keV level was also observed in the iron host. The nuclear g factor of this state is g = +0.26 ± 0.09. (auth) (Canada)

39677 FISSION OF BISMUTH NUCLEI BY ELECTRONS. Babchenko, A. V.; Petrenko, V. V.; Ranyuk, Yu. N.; Sorokin, P. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 863-4 (May 1968). (In Russian).

A Bi target was exposed to electron beams from 320-MeV and 2-GeV linear accelerators, and the fission fragments were detected using coated glass detectors. The photofission cross section was investigated at energies above the giant resonance region, and the ratio of the cross sections for electrofission and photofission were studied as a function of electron energy. (D.C.W.)

39678 EXCITATION OF ZERO, TWO, AND FOUR QUASIPARTICLES IN TAMM-DANCOFF THEORIES OF EVEN-PARITY STATES OF EVEN TIN ISOTOPES. Ottaviani, P. L. (CNEN, Bologna); Savoia, M.; Sawicki, J. Nuovo Cim., 56B: 149-65 (July 11, 1968).

The quasiparticle second Tamm-Dancoff (QSTD) theory is applied to the study of even-parity states of even tin isotopes, and compared with the quasiparticle Tamm-Dancoff (QTD) theory. Numerical computations were performed with several Gaussian and P_2 residual interaction potentials. In contrast to previous results with a delta force, reasonable finite-range forces permit accounting for the 0^+ states as well as for the 2^+ and 4^+ states. Four quasiparticle correlations are included in the ground state. The spurious states of the nucleon number operator are projected out. While the first excited 2_1^+ and 4_1^+ states are generally of almost pure two-quasiparticle character, the first excited 0^+ state is quite of the 2qp-4qp mixed type. The E2 transition probabilities and Q_2, the quadrupole moments of the 2_1^+ states are calculated and discussed. The QSTD values of Q_2 can be quite large because of the most important contributions of the mixed 2qp-4qp terms. For one of the Gaussian forces Q_2(A = 116) = +0.15 b, a value lying within the limits of the experimental errors. The theory is based on the spherical-shell model. (auth)

39679 BETA-GAMMA DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{143}Ce. Raju, M. L. Narasimha; Sastry, D. L.; Kondaiah, E. (Andhra Univ., Waltair, India). Nuovo Cim., 56B: 29-37(July 11, 1968).

The energy dependence of the 1100-keV β-293 keV γ directional correlation was measured in the decay of ^{143}Ce with a conventional slow-fast scintillation assembly in the beta energy region (750 to 1065) keV. Results from the integral correlation showed that the correlation coefficient ϵ_4 was zero within experimental errors, while those from the differential correlation experiment showed that the coefficient ϵ_2 is small and independent of energy. The results presented here agree with the spin assignment of $^3/_2^+$ to the 351-keV level in ^{143}Pr. The angular correlation results are also discussed on the basis of ξ approximation. (auth)

Nuclear Theory

Refer also to abstracts 39291, 39346, 39428, 39431, 39432, 39565, 39574, 39580, 39581, 39583, 39585, 39593, 39595, 39596, 39601, 39615, 39624, 39627, 39630, 39640, 39641, 39647, and 39670.

39680 (AD-664054) COMPUTER PROGRAMS FOR THE ANALYSIS OF GAMMA-RAY ANGULAR CORRELATION MEASUREMENTS. Hyder, A. K. Jr.; Watson, D. D. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Aug. 1967. 129p. (ARL-67-0168). CFSTI.

A description and listing of computer programs that are useful in the analysis of data on intensity-direction correlations of successive radiative transitions from aligned nuclei. A brief discussion of the methods used in extracting energy level spins, population parameters, and multipolarity mixing ratios from intensity-direction correlation measurements is given. The methods provide for simultaneous analysis of angular-distribution and triple-correlation measurements, and can be used for the analysis of double- and triple-correlation measurements where multi-step cascades involving intermediate unobserved transitions occur. The computer programs described are written in FORTRAN IV for use on an IBM 7094 computer. The complete program listings are included together with flow charts. Listings of sample input to and output from the programs are given. In addition, a description and listing is given of a program for the calculation of correction factors for finite geometry effects. (auth) (USGRDR)

39681 (BNL-12628) RADIO FREQUENCY MEASUREMENTS OF ELECTRIC AND MAGNETIC MOMENTS OF NUCLEI. Cohen, Victor W. (Brookhaven National Lab., Upton, N. Y.). June 24, 1968. 35p. (CONF-680901-1). Dep. CFSTI.

From 15th A.M.P.R.E. Colloquium, Grenoble, France.

The various methods of investigating nuclear electric and magnetic moments are briefly discussed, and some recent developments in the field are outlined. (D.C.W.)

39682 (CNEA-207) CALCULO DE LOS NIVELES DE ENERGIA DE NUCLEOS PARES ASIMETRICOS DEBIDOS A ROTACIONES Y VIBRACIONES BETA Y GAMMA. (Numerical Calculations of the Energy Levels of Asymmetric Even Nuclei Due to Rotations and Beta- and Gamma-Vibrations). Suarez, J. F.; de Aisenberg, E. Y. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1967. 16p. (In Spanish). Dep.

The dependence of collective excitations in even nuclei on the parameters of the Davydov model was investigated. The results are presented in graphical and tabular form. (D.C.W.)

39683 (CONF-670970) PROCEEDINGS OF THE SYMPOSIUM ON DIRECT REACTIONS WITH ^{3}He [HELD IN TOKYO, JAPAN, SEPTEMBER 6, 1967]. IPCR Cyclotron Progress Report, Supplement 1. Matsuda, K.; Kamitsubo, H. (eds.) (Institute of Physical and Chemical Research, Tokyo (Japan)). Feb. 1968. 275p.

Separate abstracts were prepared for the 13 papers included. (D.C.W.)

For abstracts of individual papers see: 39577, 39578, 39602-39605, 39628, 39629, and 39684-39688.

39684 (CONF-670970-, pp 3-12) THE ^{3}He ION AS A NUCLEAR PROBE. Bromley, D. Allan (Yale Univ., New Haven, Conn. Nuclear Structure Lab.).

The use of ^{3}He-induced reactions and scattering in the investigation of nuclear structure is briefly reviewed with emphasis on DWBA analysis of the data. (D.C.W.)

39685 (CONF-670970-, pp 13-39) ELASTIC SCATTERING AND REACTIONS OF ^{3}He IONS. Bassel, R. H. (Brookhaven National Lab., Upton, N. Y.); Drisko, R. M. (Oak Ridge National Lab., Tenn.).

The energy and mass dependence of the parameters of the six-parameter optical potential is discussed on the basis of data on the scattering of ^{3}He by ^{42}Ca, ^{56}Fe, ^{58}Ni, ^{89}Y, and ^{90}Zr. It is concluded that the six-parameter potential gives a reasonable fit to most data. The DWBA analysis of (d,^{3}He), (^{3}He,d), (^{3}He,p), (t,p), (α,^{3}He), and (^{3}He,α) reactions is briefly discussed. It is concluded that the distorted-wave approximation is well able to account for the orbital angular momentum transfers in (d,^{3}He) and (^{3}He,d) reactions. It is also noted that the two-nucleon transfer reactions give reliable l assignments and, apparently, reliable relative spectroscopic strengths. The difficulties in DWBA analysis of (^{3}He,α) and (α,^{3}He) reactions are discussed. (D.C.W.)

39686 (CONF-670970, pp 41-96) OPTICAL MODEL ANALYSIS OF THE ELASTIC SCATTERING OF ^{3}He AND TRITONS BY NUCLEI. Hodgson, P. E. (Oxford Univ. (England). Nuclear Physics Lab.).

The representation of the interaction between three-nucleon systems and nuclei by an optical potential is discussed, and the results of all existing analyses are tabulated. 60 references. (auth)

39687 (CONF-670970-, pp 97-9) TWO NUCLEON TRANSFER REACTIONS. Lin, C. L. (Tokyo Univ. (Japan). Inst. of Physics); Yoshida, H. (Osaka Univ. (Japan). Dept. of Physics); Yoshida, S.

A method for calculating the form factor that appears in the DWBA cross section in the zero-range approximation is outlined considering the (t,p) reaction as an example. (D.C.W.)

39688 (CONF-670970–, pp 139-43) SOME COMMENTS ON ^{3}He-INDUCED REACTIONS. Schiffer, J. P. (Argonne National Lab., Ill.).

The applicability of the (^{3}He,p), (^{3}He,d), and (^{3}He,α) reactions in nuclear spectroscopy is briefly discussed. It is noted that the (^{3}He,d) reaction agrees well with DWBA calculations with standard optical parameters and yields spin assignments and consistent spectroscopic factors. The (^{3}He,α) reaction is shown to be less amenable to DWBA analysis and to be useful for making spin assignments to states with high l values. The (^{3}He,p) reaction involving the transfer of a deuteron in the singlet state is considered; some results obtained for the energies of the isobaric analog states of even Ca isotopes using this reaction are summarized. (D.C.W.)

39689 (ITF-68-13) NUCLEAR DEFORMABILITY AND QUADRUPOLE MOMENTS. Davydov, A. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 26p. Dep.

A survey is presented of the present phenomenological theory of collective excited states in spherical and nonspherical even-even nuclei. It is shown that the character of excited states depends essentially upon the two parameters specifying the nuclear equilibrium shape in the ground state as well as two other dimensionless parameters specifying the longitudinal and transversal deformability of the nuclear surface. Relative to these parameters, the nuclei are subdivided into rigid and soft ones. In the soft nuclei the rotations are not separated from the vibrations. The above parameters are computed from the data concerning energies of three excited levels. The reduced transition probabilities for E2 transitions between excited states are also expressed in terms of these parameters. Sum rules for reduced E2 transition probabilities and expectation values of quadrupole moments in excited states are discussed. It is shown that the theory of nonspherical deformable nuclei yields expectation values of the quadrupole electric moments of the first 2^+ excited state in good agreement with experimental data for isotopes of the nuclei Cd, Ba, Sm, and Gd. (auth)

39690 (ITF-68-14) SPEKTR KOLEBATEL'NYKH I VRASHCHATEL'NYKH VOZBUZHDENII SISTEMY CHETYREKH CHASTITS. (The Spectrum of Vibrational and Rotational Excitations of Four-Particle System). Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 20p. (In Russian). Dep.

The vibrational and rotational spectrum of a four-particle system in which the two-particle interaction corresponds to the repulsion when distances between the particles are small and to the attraction otherwise is studied. In the case of four similar particles, the Hamiltonian of small vibrations is analogous to that of the generalized model for spherical nuclei and there is no low-lying rotational spectrum. In the case for which the inertia ellipsoid of the equilibrium shape has a symmetry axis, the rotational spectrum makes its appearance. (auth)

39691 (JINR-P2-3857) SINGLE-PARTICLE LEVELS OF A FINITE DEFORMED POTENTIAL. Pashkevich, V. V.; Strutinskii, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 17p. (In Russian). Dep.

A method is presented for calculations of a single-particle energy spectrum and wave functions of a Hamiltonian with a finite axially symmetric diffused potential. The wave functions are expanded in the eigenfunctions of a deformed harmonic oscillator. High efficiency of the method was achieved due to the proper choice of the basis for every deformation and rational calculation of the matrix elements. The energies of both bound and quasistationary states can be calculated. (auth)

39692 (JINR-P4-3849) CONNECTION BETWEEN THE BRUECKNER REACTION MATRIX AND THE EFFECTIVE FORCE OPERATOR FOR THE NUCLEAR RPA. Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

A possibility of determining the effective force for the nuclear RPA by using the existing calculations of the binding energy in nuclear matter and finite nuclei was studied. (auth)

39693 (JINR-P4-3873) EFFECTIVE FORCE FOR THE NUCLEAR VARIANT OF THE RPA. Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. (In Russian). Dep.

The nuclear RPA equations have been obtained from the formally precise relations, allowing one to analyze the renormalization of the effective force which determines the structure of the lowest states of nuclei. (auth)

39694 (JINR-P4-3903) INTERACTION OF QUASIPARTICLES WITH PHONONS IN DEFORMED NUCLEI. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 27p. (In Russian). Dep.

The effect of the quasiparticle-phonon interaction on the structure of ground and excited nonrotational states of deformed nuclei is studied. It is shown that by increasing the excitation energy the structure of quasiparticle states becomes more complicated, i.e., the role of admixtures increases. (auth)

39695 (UCRL-17989, pp 101-25) NUCLEAR STRUCTURE THEORY. (California Univ., Berkeley. Lawrence Radiation Lab.).

The accuracy of the wave functions in Wigner's supermultiplet theory was studied with emphasis on heavy nuclei. Starting from the mass formula in the supermultiplet theory, formulas for the neutron separation energy and the difference between the neutron separation energies of two isobars were derived. Numerical calculations were performed, and the results were confronted with experimental data. A theoretical study of the structure and stability of element-114 was also made. (D.C.W.)

39696 (UCRL-18225) TWO-NUCLEON TRANSFER REACTIONS. Glendenning, Norman K. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 17p. (CONF-680439-1). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

Qualitative features of two nucleon transfer reactions are discussed. The role of the residual interaction and the single-particle spectrum in distributing the transition strength is emphasized, showing how, among states of the same spin, it is sometimes concentrated into the lowest states while other times is spread over several states. The validity and success, under appropriate circumstances, of the simple direct mechanism is illustrated. In some situations higher-order effects are expected to play a dominant role. A novel means of including the effects of core excitation on transfer reactions in a practical calculation is outlined. (auth)

39697 (UCRL-50430) A FORTRAN PROGRAM FOR THE NUMERICAL SOLUTION OF N COUPLED, ONE-DIMENSIONAL, REDUCED SCHROEDINGER WAVE EQUATIONS. Tarp, Raymond L. (California Univ., Livermore. Lawrence Radiation Lab.). May 17, 1968. 37p. Dep. CFSTI.

WAVE is a Fortran program which solves a system of N coupled, one-dimensional, reduced Schroedinger equations to obtain the bound-state solutions. Either the Runge–Kutta or Noumerov scheme is used to integrate outward from zero to a matching radius RMATCH and inward from a maximum radius RMAX to the same RMATCH. The present program utilizes a Woods–Saxon local central potential for the noncoupled potential and a Coulomb potential for the coupling between equations. These potentials may readily be altered. (auth)

39698 (UR-875-234) EFFECTIVE INTERACTIONS IN NUCLEI AND TWO NUCLEON SCATTERING. Koltun, Daniel S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). May 14, 1968. Contract AT(30-1)-875. 22p. (CONF-680437-1). Dep. CFSTI.

From 3rd International Symposium of the Structure of Low-Medium Mass Nuclei, Kansas City, Mo.

Several ways in which the residual interaction can be related to two-body scattering are discussed. The residual interaction is considered to split shell-model states of a given configuration and is defined to be an effective two-body interaction. (D.C.W.)

39699 NUCLEAR FORCES. III. Feshbach, Herman; Kerman, Arthur K. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 2: 78-82(May-June 1968).

The determination of the nature of the two-nucleon potential on the basis of observations on three-body as well as two-body systems is discussed under the assumption that the effects of three-body forces can be neglected. The interpretation of two- and three-body data by the introduction of noncentral potentials, particularly tensor forces, is considered in some detail. (D.C.W.)

39700 THE LITERAL TRUTH OF THE SHELL MODEL: NUCLEON PAIRS. Wilkinson, Denys H. (Oxford Univ.). Comments Nucl. Particle Phys., 2: 83-90(May-June 1968).

Two classes of experimental tests of the realistic shell model that involve the observation of nucleon correlation effects in the absorption of pions are briefly discussed. It is noted that the experiments support the validity of the bases of the shell model. (D.C.W.)

39701 SPIN CUT-OFF EVALUATION FOR (n,2n) REACTIONS INDUCED BY 14-MeV NEUTRONS. Minetti, B.; Pas-

quarelli, A. (Politecnico, Turin). Nuovo Cim., 56B: 201-2 (July 11, 1968).

The spin cut-off parameters for (n,2n) reactions on several nuclei with A = 134 to 208 were evaluated using Huizenga and Vandenbosch's (Phys. Rev., 120: 1305 and 1313(1960)) correlation of the cut-off parameter with the isomeric cross-section ratio. (D.C.W.)

39702 PROTON WIDTHS OF ANALOG STATES IN HEAVY NUCLEI. Devyatko, Yu. N.; Zaretskii, D. F.; Urin, M. G. (Tbilisi State Univ., USSR). Yadern. Fiz., 7: 1021-8(May 1968). (In Russian).

A microscopic approach is applied to the proton resonance scattering with excitation of analogue states in heavy nuclei. Partial proton widths are calculated for the case of the resonance scattering on nuclei ^{208}Pb and ^{207}Pb. The results of the calculations are compared with experimental data. (auth)

39703 PHENOMENOLOGICAL NUCLEON–NUCLEON POTENTIALS. Reid, Roderick Vincent Jr. Ithaca, N. Y., Cornell Univ., 1968. 89p.

Thesis.

Hard- and soft-(Yukawa) core potentials were fitted to Yale and Livermore phase parameters and low-energy data. The potentials are local and static except that a different one is used for each state of distinct isotopic spin, total spin, and total angular momentum. It is found that neither the short-range behavior of the potentials nor the central-to-tensor ratio in the $^3S_1-{}^3D_1$ state is well determined by the data. Present data do exclude potentials containing only local central, tensor, and spin-orbit terms. Addition of a quadratic spin-orbit potential such as that used by the Yale group or by Hamada and Johnston helps greatly but is probably not enough to accurately reproduce the data. A method for solving the Schroedinger equation with a mixture of local and separable potentials is given. (Diss. Abstr.)

39704 DEUTERON WIDTH. Kumar, A.; Bye, B. H. (Saha Inst. Nucl. Phys., Calcutta). Nature (London), 218: 1045-6 (June 15, 1968).

The probability density of finding the last neutron and proton in a nucleus in a deuteron state is called the deuteron width in the nucleus and is directly proportional to the product of single-particle fractional parentage coefficients for the separation of the neutron and proton from the nucleus. The other factor is statistical weight, which can be obtained if the wave function of the deuteron moving about the core is known. The product of the wave functions of the last neutron and proton may be written in terms of the relative and cms co-ordinates of these particles. Multiplying the product with a suitable deuteron wave function of the Hulthen type and integrating over the relative co-ordinate, the wave function about the core is obtained. The method of deuteron width outlined will help in deciding the right configurations of heavy particle stripping in (d,p), (d,n) reactions and will be of use in studying stripping reactions such as (^{3}H,n), (^{3}He,p), (^{4}He,d). It is also suggested that the square-well solution to describe the deuteron-core bound state would prove much better in a distorted-wave stripping calculation. The theory is based on the independent-particle model of the nucleus. (UK)

39705 DEUTERON SCATTERING IN NUCLEAR MATTER. Ismatov, E. (Inst of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz-Mat. Nauk, No. 1, 37-9(1968). (In Russian).

The optical model was used to study nuclear interactions of deuterons. The virtual part of the optical potential for the particle in the nucleus was found directly by considering nucleon wave scattering on the random density fluctuations of nuclear matter. The cross sections for deuteron elastic scattering and deuteron breakup were calculated. (R.V.J.)

39706 ELECTRIC QUADRUPOLE TRANSITIONS BETWEEN ROTATIONAL SINGLE-PARTICLE STATES IN DEFORMED ODD NUCLEI. Isakov, B.; Shariopov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz-Mat. Nauk, No. 1, 62-4(1968). (In Russian).

The effect of deformation in odd nuclei on the reduced E2 transition probabilities for the ground-state rotational band was calculated for nuclei with small non-axiality. It was found that deformation exerts considerable influence on the E2 transition probabilities. (R.V.J.)

39707 PROBABILITIES OF ELECTROMAGNETIC TRANSITIONS IN ODD–ODD SPHERICAL NUCLEI. Korolev, A. M. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1701-7(Oct. 1967). (In Russian).

The probabilities of E2 and M1 transitions between excited states and the ground state were investigated using a simple model in which nucleon pairs interact with a closed core and excite the collective degrees of freedom of the core. As a specific example, E2 transition probabilities for two-phonon states of ^{110}Cd, ^{112}Cd, ^{114}Cd, and ^{116}Cd were calculated and were compared with experimental data. (R.V.J.)

39708 PROBABILITIES OF 1-FORBIDDEN M1 TRANSITIONS AND MAGNETIC MOMENTS OF ODD SPHERICAL NUCLEI. Birbrair, B. L.; Gusinskii, G. M.; Isakov, V. I.; Lemberg, I. Kh. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1696-1700 (Oct. 1967). (In Russian).

Probabilities of 1-forbidden M1 transitions of nuclei in which protons and neutrons simultaneously fill up the shell (28 to 50 or 50 to 82) were calculated considering the superfluidity in the nuclei far from the magic regions. The magnetic moments of ground-state nuclei were obtained. The results for ^{61}Ni, ^{85}Rb, ^{87}Rb, and ^{91}Zr, in which the proton and neutron shells are 28 to 50, and for ^{123}Te, ^{129}Sb, and ^{133}Cs (with 50 to 82 shells) are tabulated. (R.V.J.)

39709 CENTRIFUGAL STRETCHING OF A CLASSICAL ROTATOR AND COLLECTIVE MOTIONS IN NUCLEI. Sood, P. C. (Univ. of Alberta, Edmonton). Can. J. Phys., 46: 1419-23(June 15, 1968).

The energy of a classical rotator with the inclusion of the effect of centrifugal forces is calculated. The resulting set of parametric equations is found to yield an excellent description of rotational states in deformed nuclei. The formulation within the framework of the hydrodynamical model also predicts β-vibrational energies in good agreement with the observed levels. The results are practically identical with those obtained from the Davydov–Chaban model with axial symmetry. Comparison with other models, which include the rotation–vibration interaction corrections, establishes the relative merit of our simple approach. (auth) (Canada)

39710 APPLICABILITY OF THE STATISTICAL MODEL TO THE DESCRIPTION OF THE POPULATION OF GROUND-STATE ROTATIONAL LEVELS. Mills, S. J.; Rautenbach, W. L. (Council for Scientific and Industrial Research, Pretoria). Phys. Lett., 27B: 207-8(July 8, 1968).

Comparison of the relative intensities of ground-state rotational transitions occurring in ^{178}W, ^{180}W, and ^{182}W, following (α,2nγ) reactions, shows that the statistical model of nuclear reactions is not applicable to the description of these intensities. (auth)

39711 HYPERFINE STRUCTURE INTERACTION IN DIRECTIONAL CORRELATION MEASUREMENTS OF GAMMA RAYS. Golczewski, J. (Inst. of Nuclear Physics, Krakow). Postepy Fiz., 19: No. 1, 87-97(1968). (In Polish).

A description is given of the directional correlation of gamma-ray cascade perturbed by the interaction of the hyperfine structure (hfs) for isolated atoms and for liquids and solids. The perturbation of $\gamma-\gamma$ directional correlation caused by magnetic hfs interaction in the presence of an external magnetic field was examined. Possibilities of utilizing measurements of this kind for determining the magnetic moments of excited states of nuclei are presented. (auth)

39712 E2 TRANSITIONS FROM THE γ BAND LEVELS IN ROTATION-VIBRATION NUCLEAR MODEL. Begzhanov, R. B.; Belen'kii, V. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR. Ser. Fiz.-Mat. Nauk, No. 2, 64-9(1968). (In Russian).

The ratios of probabilities of E2 transitions between γ band levels do not depend much on the parameters of the rotation-vibration theory. The ratios of probabilities of transitions from the levels of the γ band to the ground-state rotational band level can be roughly divided into two groups: one group with smooth transitions from the odd-spin levels and another group with a more complex E_γ and E_β relation. (R.V.J.)

39713 N-FORBIDDEN BETA TRANSITIONS IN ODD-MASS DEFORMED NUCLEI. Chernej, M. I.; Gareev, F. A.; Kalinkin, B. N.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 27B: 117-19(June 24, 1968).

The effect of the $\Delta N = 2$ mixing of states from different principal harmonic shells on β-transitions between odd-mass deformed nuclei is considered using Woods-Saxon single-particle wave functions. The value of log $(ft)_{s.p.} = 6.2-6.4$ is obtained for all the N-forbidden transitions. Taking into account pairing correlations brings into satisfactory agreement the calculated and experimental log ft. (auth)

39714 EIGENPOTENTIAL PROBLEM OF THE SHELL MODEL. Morsy, M. W. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 265-70(1968).

A method is given for extracting the eigenparameters of any arbitrary single-particle potential, that provides a complete set of eigenfunctions which have the proper asymptotic behavior and which reproduces nearly all the observed single-particle features. The method is applied to Saxon Woods potential. A computer program is set up in which one could insert single-particle observables to get out eigenparameters. The region around the double magic nucleus ^{16}O have been investigated to extract the eigenpotential parameters and the bound-state eigenfunctions. (auth)

39715 THE MODEL DEPENDENCE OF THE N(e,e')N* FORM FACTORS. Pritchett, P. L.; Thornber, N. S.; Walecka, J. D.; Zucker, P. A. (Stanford Univ., Calif.). Phys. Lett., 27B: 168-71(June 24, 1968).

An attempt is made to draw some conclusions on the model-dependent and model-independent features of the N(ee')N* form factors by investigating the predictions of several models of the nucleon. A comparison is made with existing data. (auth)

39716 COULOMB STRIPPING OF DEUTERONS ON DEFORMED NUCLEI. Abul-Magd, A. Y.; El-Nadi, M.; Sharaf, M. A. (Atomic Energy Establishment, Cairo. Cairo Univ.). Atomkernenergie, 13: 262-4(1968).

Deuteron stripping on deformed nuclei is considered at incident energies below the Coulomb barrier. Comparison with the experimental data shows satisfactory agreement. (auth)

39717 RECOIL OF FISSION PRODUCTS. II. IN HETEROGENEOUS CARBON STRUCTURES. Evans III, R. B.; Rutherford, J. L.; Perez, R. B. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 39: 3253-67(June 1968). (ORNL-P-3584).

A previously reported investigation of the recoil behavior of "light" and "heavy" fission fragments in a uniform pyrocarbon structure was extended to include five additional structures with porosities ranging from 5 to 23 vol%. As before, fragments were induced to penetrate target structures as nearly monoenergetic beams with random r-space directions. Data were collected and arranged to produce plots of fractional activities remaining at various grinding levels along the z coordinate normal to thin (neutron-activated) ^{235}U source planes. Such plots are integrated forms of the z-space probability-density functions (called distribution functions); these, in turn, are specified by associated r-space functions. An important facet of these studies was the development of integrated z-space equations that would exhibit good agreement with data for porous structures. Selection of realistic r-space functions was therefore mandatory. Application of the proper integrated equations permitted evaluation of several sets of range values that were nearly identical and independent of the structures involved. A compact expression for all results in revised form is $\log_{10}(R')_i = 0.478 \log_{10}(E_0)_i - 0.465$, where R' (mg/cm^2) is the range of any ith fragment with an initial fission energy E_0 (MeV). Although the range values for homogeneous and heterogeneous materials are the same, applicable distribution functions varied in form because of variations in pore-size characteristics from one structure to the next. In some cases, the pore sizes were equal to or greater than the range. This resulted in large straggling effects and asymmetric r-space distributions; furthermore, the R' in the above expression corresponds to the most probable distance of r-space travel. Range results for only two of the six structures investigated are correlated on the basis of a normal (or Gaussian) r-space distribution, where the average and most probable range are synonymous. Results for all other structures are correlated by using general forms of the Maxwell distribution. In these cases, the average distance traveled is always greater than R' (to an extent depending on the skewness of the distribution function selected for data correlation). (auth)

39718 CALCULATION OF CORE-POLARIZATION EFFECTS. Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 27B: 199-201(July 8, 1968).

The calculation of core-polarization in the Hartree-Fock theory is discussed and it is shown that a particularly simple treatment can be formulated using the Thomas–Fermi approximation. Preliminary calculations are reported in oxygen isotopes, and the results are very satisfactory. (auth)

39719 INELASTIC ALPHA PARTICLE SCATTERING: GAMMA DEEXCITATION PATTERN OUTSIDE REACTION PLANE. Tolsma, L. D.; Verhaar, B. J. (Technische Hogeschool, Eindhoven, Netherlands). Phys. Lett., 27B: 192-4(July 8, 1968).

A simple three-dimensional model for inelastic scattering of alpha particles is used to predict the behavior of the deexcitation gamma pattern outside the reaction plane as a function of alpha particle scattering angle. The results agree qualitatively with DWBA predictions. (auth)

39720 AZIMUTHAL ASYMMETRY IN ELECTRON SCATTERING BY EXTENDED NUCLEI. Kolesnikov, V. N. Ukr. Fiz. Zh., 13: 865-7(May 1968). (In Russian).

A standard procedure was used for describing the azimuthal asymmetry of the electron distribution in binary Mott scattering on an arbitrary charge distribution which is characterized by the form factor $F(q^2)$. Three models of the charge distribution (Yukawa, exponential, and expanded exponential) were examined. The results obtained showed that the nuclear charge structure plays a considerable part in polarization phenomena in binary high-energy electron scattering. With small transmitted pulses, the effect of the structure is negligible; but at high energies and large scattering angles it becomes important. (R.V.J.)

39721 DEVELOPMENT TREND OF NUCLEAR PHYSICS IN THE NEAR FUTURE. Bethge, Klaus (Univ. of Pennsylvania, Philadelphia). Phys. Bl., 24: 209-12(May 1968). (In German).

The factors affecting the development trends of nuclear physics in the near future are reviewed. Atomic physics as pure science, the political factors, and military factors are considered. (J.S.R.)

39722 ON THE INFLUENCE OF THE DEUTERON INTERNAL STRUCTURE ON DIFFRACTION DISINTEGRATION. Sitenko, A. G.; Berezhnoi, Yu. A.; Evlanov, M. V. Ukr. Fiz. Zh., 13: 804-9(May 1968). (In Russian).

The influence is considered of the finite radius of the neutron-proton nuclear interaction in a deuteron and of the deuteron internal structure on the angular and energy distributions of deuteron disintegration products. (auth)

39723 ON THE PROBLEM OF THE ASYMPTOTIC EQUALITY OF THE DIFFERENTIAL CROSS SECTIONS OF SCATTERING CROSS REACTIONS OF PARTICLES WITH AN ARBITRARY SPIN. Khimich, I. V. Ukr. Fiz. Zh., 13: 810-15(May 1968). (In Russian).

The asymptotic helical amplitudes $G^{(\infty)}_{\{\lambda\}}(s,t)$ and $H^{(\infty)}_{\{\lambda\}}(s,t)$ were introduced. It was proved that they satisfy all the requirements which are necessary for applying the Phragmen–Lindelöff–Nevanlinna maximum principle to them. On this basis, the asymptotic equality was proved of the differential cross sections of binary scattering processes of particles with an arbitrary spin, proceeding only from the most general axioms of the modern local quantum field theory without an additional assumption concerning analyticity of the exact amplitudes $G_{\{\lambda\}}(s,t)$ and $H_{\{\lambda\}}(s,t)$. (auth)

39724 ON THE EFFECT OF A REPULSIVE CORE ON NUCLEON SCATTERING IN NUCLEAR MATTER. Shadchin, S. A. Ukr. Fiz. Zh., 13: 839-47(May 1968). (In Russian).

The nucleon interaction being described by a non-local separable potential with account of a repulsive core, a quantum-mechanical problem on the scattering of a nucleon pair is considered in the framework of Brueckner's theory of nuclear structure. The position of the poles of the scattering amplitude depending on the total momentum of a nucleon pair and the nuclear density is investigated. (auth)

39725 INFLUENCE OF THE SHELL STRUCTURE OF FRAGMENTS ON FISSION PROCESS. Ignatyuk, A. V. Yadern. Fiz., 7: 1043-50(May 1968). (In Russian).

The effect of the shell structure on the deformation of fission products is investigated in the framework of the model of noninteracting particles moving in a deformed potential. In order to determine the fragment yield, the potential energy of the fissioning nucleus before the separation is calculated. It is shown that the energy minimum corresponds to the asymmetrical mode of the fission for heavy fissioning nuclei and to the symmetrical mode for the light nuclei. Deformations and fragment charges thus obtained can be used to explain experimental data on the mean kinetic energy distribution and the most probable charge of fragments. (auth)

39726 GEOMETRIC MODEL OF SYMMETRIC FISSION. Stavinskii, V. S.; Rabotnov, N. S.; Seregin, A. A. Yadern. Fiz., 7: 1051-5(May 1968). (In Russian).

A one-parameter equation for the surface of rotating bodies with constant volume is proposed to describe equilibrium figures of a uniformly charged liquid drop with the constant surface tension and to model deformed configurations suffered by an atomic nucleus during the symmetric fission process. The surface and the Coulomb energies are calculated as well as the momenta of inertia of rotating bodies, the generatrix of which is the Cassini line. The results are in good agreement with the parameters of the saddle form of the drop model obtained using the exact numerical solution of the Strutinsky's equilibrium equation. The model described is convenient for a simple dynamical description of the fission process with one degree of freedom. (auth)

39727 FORM FACTORS IN AN EXACTLY SOLVABLE MODEL OF MANY PARTICLES. Simenog, I. V. (Inst. of Physics, Keiv). Yadern. Fiz., 7: 992-1000(May 1968). (In Russian).

A model of A particles with the pair oscillator interaction is considered. This model is a plausible description in the case of small effective distances between the particles. Elastic and inelastic form factors for the symmetrical ground state (arbitrary A) and elastic form factors for antisymmetrical states ($A \leq 4$) are investigated. Improvement of the model, i.e., the account of the spin dependence and the account of two types of the particles, is considered. (auth)

39728 FRACTIONAL PARENTAGE DECOMPOSITION OF SUPERMULTIPLET NUCLEAR WAVE FUNCTION. Vanagas, V. V.; Petrauskas, A. K. (Inst. of Physics, Riga). Yadern. Fiz., 7: 1001-10(May 1968). (In Russian).

General properties of the fractional parentage decomposition with the separation of an arbitrary number of quasiparticles are studied for a wave function in the approximation of the Wigner's supermultiplets. A possible interpretation of the nuclear wave function in the scheme $U(3(n-1)) \supset SU(3) \times U(n-1)$ is discussed, and the structure of the matrix of the fractional parentage decomposition is considered for such a function. (auth)

39729 FOUR-PARAMETER OPTICAL POTENTIAL FOR DEUTERONS. Averyanov, I. K.; Purtseladze, Z. Z. Yadern. Fiz., 7: 1011-15(May 1968). (In Russian).

An optical potential for deuterons, specified by four parameters, is presented. The spin-orbit interaction is not taken into account. The calculations are carried out for deuterons with energies 12 MeV $\lesssim E_d \lesssim$ 28 MeV. The agreement between the theory and the experiment is satisfactory, up to the inclusion of the effects of the spin-orbit interaction, the internal deuteron structure, and specific properties of some nuclei. (auth)

39730 LOWER BOUNDS TO THE GROUND-STATE ENERGY OF N-BODY SYSTEMS AND CONDITIONS ON THE TWO-BODY POTENTIALS NECESSARY FOR THE EXISTENCE OF N-BODY BOUND STATES. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Simonov, Yu. A. Nuovo Cim., 56B: 71-82(July 11, 1968).

Simple lower bounds to the ground-state energy of N-body systems, and conditions on the two-body forces which are necessary for the existence of N-body bound states are obtained. The simpler version of these conditions reads (with an obvious meaning of the symbols) $-2\hbar^{-2}\int_0^\infty dr\, r \sum_{i>j}^N m_i m_j (m_i + m_j)^{-1} V_{ij}(r)\,\theta[-V_{ij}(r)] \geq 1$; thus it provides the direct N-body generalization of the well-known Jost-Pais condition. (auth)

39731 THREE-NUCLEON BOUND STATE. Brink, David M.; Peierls, Rudolf E. (Oxford Univ.). Comments Nucl. Particle Phys., 2: 92-6(May-June 1968).

Variational methods for estimating properties of the three-body system are briefly discussed, together with Faddeev's method for direct solution of the three-body problem. (D.C.W.)

39732 ALPHA-PARTICLE MODEL FOR NUCLEAR MATTER. Khanna, K. M. (Dibrugarh Univ., India). Czech. J. Phys., 18: 821-9(1968).

Infinite nuclear matter is assumed to be composed of an equal even number of protons and neutrons. The surface region of nuclear matter is replaced by an assembly of alpha particles interacting through a potential composed of a strong short-range repulsion and a weak long-range attraction of the Gaussian form. The energy gap in nuclear matter and the effective mass of alpha particles have been calculated. The result shows that the energy gap Δ is more than 2 MeV but $\leq$5 MeV. The ratio of the effective mass m^* to the free particle mass m of alpha-particles is always greater than unity and its maximum value is a little over 5. For an assembly of alpha particles to be stable, it must be a dilute weakly interacting assembly. The net interaction must be repulsive and the nuclear density should be less than the saturation limit. The results have been compared with previous calculations. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 37910, 37920, 38142, 38527, 38589, and 38605.

39733 (AAEC/TM–441) REVIEW OF BURNOUT STUDIES IN FREON AND DESCRIPTION OF A FREON LOOP. Price, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1968. 19p. Dep.

The need for simulation in studies of burnout or critical heat flux for application to nuclear reactor design is outlined. The available literature on the suitability of Freon as a model fluid for water is reviewed and discussed. A brief description is given of a Freon loop currently under construction at the A.A.E.C. Research Establishment. (auth)

39734 (AI-AEC–12687) LMFBR FISSION PRODUCT CONTAMINATION AND CONTROL STUDIES: A STATUS REPORT. Kunkel, W. P.; Pollock, B. D.; Guon, J.; Zwetzig, G. B.; Silberberg, M.; Berger, S. (Atomics International, Canoga Park, Calif.). June 30, 1968. Contract AT(04-3)-701. 78p. Dep. CFSTI.

The status of studies and experiments being conducted at Atomics International to describe the distribution of fission products and other contamination sources released to the coolant of a Liquid Metal Fast Breeder Reactor (LMFBR) is presented. These studies include the formulation of Radiological Hazard and Radiation Indices to aid in determining the most significant fission products, the evaluation of the importance of activated core materials which are subsequently corroded into the coolant stream, the classification of fission products on the basis of physical and chemical properties into analog groupings to reduce the number of isotopes which must be studied in sodium test loops, and a preliminary study of the residual radiation levels which could result from fission product plating on heat exchanger surfaces, thereby limiting access for maintenance or repair. Experimental results derived from studies of cesium and sodium iodide vaporization from sodium solutions and cesium cold trapping studies are presented. The Fission Product Behavior Loop which will be used for a more comprehensive series of investigations of fission product behavior in sodium is also described. (auth)

39735 (APDA–305) NUCLEAR TEST PROGRAM FOR THE ENRICO FERMI FAST BREEDER REACTOR. Branyan, C. E.; Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 398p. Dep. CFSTI.

The nuclear test program that was developed for the Enrico Fermi Fast Breeder Reactor is described. This test program is the nuclear portion of the total plant test program that was conducted for the Fermi reactor. Therefore, the information covered is concerned with core and blanket physics measurements and control systems tests. The initial planning and background studies which led to a definition of the general character of the program are reviewed; the objectives and various preparations required prior to conducting the tests are given. The preparation of the test procedures, the manpower requirements, and the scheduling and coordination of the tests are discussed. Emphasis is given to the consideration of special test equipment and instrumentation, reactor and plant control, and any safety requirements involved in conducting the test program. The methods of making reactivity measurements and their experimental accuracy are described. Each of the nuclear tests is summarized in the body of the report under two primary categories: low-power tests, one thermal megawatt or less; and high-power tests, greater than one thermal megawatt. Within these categories, the tests are subdivided according to the general nature or purpose of the test. These subcategories are nuclear characteristics, calibration measurements, mechanical characteristics, reloadings, stability measurements, and transient tests. A brief evaluation of the test program, in view of the experience gained during development and conduct to date, is given. A compilation of the nuclear test procedures written for each test is appended. (auth)

39736 (BNWL–802) RESULTS OF HEAVY WATER REACTOR CALCULATIONS MADE WITH SWEDISH CODES, BOP AND BIOP. Burnham, J. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

The independent variables of the BOP and BIOP codes are listed; the programs are described. A reference 1000 MW(e) indirect cycle heavy water reactor is used as a model. Capital costs and unit energy costs are tabulated; effects of interest rate variation are shown. Power costs are shown, also, as a function of plant capacity. A comparison of required investment for pressure vessel and pressure tube heavy water reactors is given. Effects of fuel enrichment and heavy water are evaluated. Power generation costs are tabulated for the direct cycle concept. 11 references. (M.L.S.)

39737 (CEA-N–831) DIRECT CO_2 GAS CYCLE FOR A.G.R. TYPE REACTORS. Maillet, Ennemond (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 55p. (In French). Dep.

A complete description of a direct CO_2 cooling system for AGR-type reactors is given. Coolant characteristics are outlined; required cooling system equipment is described. The steam and power conversion systems are discussed; requirements are outlined. Problems associated with the CO_2 cooling system are listed. Entropy and enthalpy curves and temperature-pressure diagrams for the CO_2 are shown. 13 references. (M.L.S.)

39738 (CONF-671103–6) AN APPRAISAL OF NUCLEAR ENERGY FOR INDUSTRIAL HEAT AND POWER SUPPLIES. Decker, G. L. (Dow Chemical Co., Midland, Mich.); Wilson, W. B. (General Electric Co., Schenectady, N. Y.); Bigge, W. B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). [1967]. 22p. Dep.

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York.

The use of reactors for production of electricity and heat is discussed. Relative economics of fossil and nuclear plants for supplying heat and power to industry are evaluated; economic data are shown graphically. (M.L.S.)

39739 (CVNA–176) CVTR HEAVY WATER ACCOUNTABILITY. Glass, Caleb D. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Apr. 22, 1963. 71p. Dep. CFSTI.

A complete description of CVTR heavy water accountability procedures and operations is given. Problem areas in heavy water accountability are identified. Initial fill data are given. The CVTR system is described in detail; systems diagrams and schematics are shown. Calibration curves are given for the cooling system and components. (M.L.S.)

39740 (DOCKET-50155–2) BIG ROCK POINT PLANT. VOLUME ONE. PLANT TECHNICAL DESCRIPTION AND SAFEGUARD EVALUATION. VOLUME TWO. PART I. ENGINEERING DRAWINGS. PART II. TOPICAL REPORTS. Final Hazards Summary Report. (Consumers Power Co., Jackson, Mich.). Nov. 14, 1961. 387p. (NP–11153(Vol.1 and 2)). Dep. CFSTI.

Information on Big Rock Point Power Reactor is given under the following broad topics: Introduction and Conclusions; Plant Site and Environment; Containment; Reactor; Reactor System Equipment; Power System Equipment; Instrumentation; Nuclear, Thermal, and Hydraulic Characteristics; Radioactive Waste Disposal; Research and Development Program; Operating Procedures; Safety Analysis; and Maximum Credible Accident. (M.L.S.)

39741 (DOCKET-50155–3) [BIG ROCK POINT PLANT]. APPLICATION FOR REACTOR CONSTRUCTION PERMIT AND OPERATING LICENSE. Preliminary Hazards Summary Report, Part B. (Consumers Power Co., Jackson, Mich.). Jan. 18, 1960. 257p. (NP–8329). Dep. CFSTI.

Information on Big Rock Point Power Reactor is given on: the plant description, nuclear characteristics of the reactor, site and environment, and safeguards considerations. Appendices include information on: climatological data, meteorology, geology and hydrology, lake currents, seismology, and research and development program. (M.L.S.)

39742 (DOCKET-50155–4) [BIG ROCK POINT PLANT]. [Preliminary Safety Analysis Report], Amendment 2. (Consumers Power Co., Jackson, Mich.). Oct. 17, 1960. 404p. (NP–9359). Dep. CFSTI.

Revised information on the Big Rock Point Power Reactor is given on the following aspects: containment, core performance, control rod drive mechanisms, and core instrumentation. Technical specifications for reactor containment are included. (M.L.S.)

39743 (DOCKET-50206–3) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. REPORT ON CABLE FAILURES, 1968. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). May 22, 1968. 325p. Dep. CFSTI.

An analysis of cause and effects of cable failures in the San Onofre Power Reactor, Unit 1 is given. Thermal loading tests are described; cable tray temperature profiles are shown. A description of events leading to cable failure is given. A safety evaluation of the occurrence and corrective action are detailed. The reactor start-up program is described. Test data are detailed; design basis and specifications for previous cables are given; engineering design drawings and system schematics are included. (M.L.S.)

39744 (DOCKET-50231-19) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 17. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). July 22, 1968. 70p. Dep. CFSTI.

Revised information for the Southwest Experimental Fast Oxide Reactor is given on the following: containment design, shielding design calculations, core design and analysis, reactor vessel and internals, seismologic analysis of the various systems. (M.L.S.)

39745 (DOCKET-50255-7) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 5. (Consumers Power Co., Jackson, Mich.). Dec. 5, 1966. 36p. Dep. CFSTI.

Availability of feedwater to the Palisades Power Reactor steam generators under accident conditions is evaluated. Development of the reactor containment building ventilation system is described; the design of the air coolers is given. Flow diagrams of the safety injection and containment spray system are shown; reactor protective systems are described. (M.L.S.)

39746 (DOCKET-50267-4) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 2. (Public Service Co. of Colorado, Denver). May 31, 1967. 357p. Dep. CFSTI.

Information on seismic and tornado loadings for the containment structure for Fort St. Vrain Power Reactor, Unit 1, is given. Heterogeneous effects of lumped burnable poisons is evaluated. Probable error ranges for calculated temperature coefficients and their effects on reactivity are considered; the fuel pellet thermodynamic characteristics used in accident calculations are discussed. Effects of steam-graphite reactions are analyzed. The helium circulators are described; failure of the circulators is evaluated. Steam generator design parameters are tabulated. The prestressed concrete reactor vessel (PCRV) design criteria are detailed; complete elastic analyses of the PCRV are included. Effects of tendon relaxation, concrete shrinkage, and creep on PCRV stress and deformation are evaluated. PCRV ultimate strength analyses are detailed; test data and failure mode analyses are given; criteria for strain and crack control are discussed. Specifications for PCRV concrete are given. Prestressing materials and procedures are detailed. Design criteria for the scram and steam/water dump systems are given. Circuit diagrams for rod-withdraw prohibit are shown. The PCRV moisture and pressure limiting systems are detailed. Failures of the post-accident control system are evaluated. Effects of external power loss are considered. Consequences of failure of a helium circulator water-lubricated bearing system are analyzed. Support is given for the argument that a conventional containment system is not necessary for Fort St. Vrain. (M.L.S.)

39747 (DOCKET-50267-5) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 5. (Public Service Co. of Colorado, Denver). Oct. 13, 1967. 216p. Dep. CFSTI.

Effects of sudden depressurization of the primary cooling system for Fort St. Vrain Power Reactor, Unit 1, are evaluated. Results of gas-blowdown and overpressure tests (to 1500 psig) on the prestressed concrete reactor vessel (PCRV) are given. Details of PCRV top and bottom head design are presented; localized shear stress resistance is evaluated. Materials specifications and requirements for the PCRV are detailed. Basic properties of the prestressing wire and liner material are outlined. The detailed design of the tendon anchor zones is given. Consequences of a PCRV penetration failure are analyzed. (M.L.S.)

39748 (DOCKET-50267-6) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 7. (Public Service Co. of Colorado, Denver). Nov. 6, 1967. 5p. Dep. CFSTI.

Estimated construction and fuel costs for the Fort St. Vrain Power Reactor, Unit 1, are given. (M.L.S.)

39749 (DOCKET-50267-7) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 8. (Public Service Co. of Colorado, Denver). Nov. 27, 1967. 153p. Dep. CFSTI.

The method used for combining earthquake stresses with an axisymmetric analysis of the prestressed concrete reactor vessel (PCRV) for the Fort St. Vrain Power Reactor, Unit 1, is described. The proposed acceptance testing program is given. Logic diagrams for the scram, steam/water dump, loop shutdown, and circulator trip circuits are included. The necessity of power-to-flow comparators is evaluated. Potential failure modes for post-accident control systems are discussed. An analysis of steam transients is given. (M.L.S.)

39750 (DOCKET-50267-8) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 1. (Public Service Co. of Colorado, Denver). Sept. 1966. 251p. Dep. CFSTI.

Information on the Fort St. Vrain Power Reactor, Unit 1, is given under the following broad headings: Introduction and Summary; Site; Reactor; Reactor Coolant System; and Prestressed Concrete Reactor Vessel including design bases, concrete, bonded reinforcing steel, prestressing, liner, penetrations and closures, thermal barrier and liner cooling system, PCRV missile protection, construction and quality control, tests and inspections, and monitoring PCRV reactions to load conditions. (M.L.S.)

39751 (DOCKET-50267-9) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 2. (Public Service Co. of Colorado, Denver). Sept. 1966. 300p. Dep. CFSTI.

Information on Fort St. Vrain Power Reactor, Unit 1, is given under the following broad subjects: Engineered Safeguards; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Secondary Coolant and Power Conversion System; Radioactive Wastes and Radiation Protection; Conduct of Operations; Initial Tests and Operation; and Safety Analysis. (M.L.S.)

39752 (DOCKET-50267-11) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. Safety Evaluation. (Public Service Co. of Colorado, Denver). June 21, 1968. 205p. Dep. CFSTI.

The safety evaluation of the Fort St. Vrain Power Reactor, Unit 1, which was performed by the AEC, Division of Reactor Licensing, is given. Information is given under the following: site and environment, plant design, accident analyses, research and development, technical qualifications of the applicant, and ACRS report. (M.L.S.)

39753 (DOCKET-50309-12) [MAINE YANKEE ATOMIC POWER STATION]. [Preliminary Safety Analysis Report], Amendment 12. (Maine Yankee Atomic Power Co., Wiscasset). July 2, 1968. 45p. Dep. CFSTI.

The control rod power supply for Maine Yankee Power Reactor is described; xenon oscillations and their effects are analyzed. Nuclear design methods are discussed. Maximum probable flood level plus wave run-up are determined; effects are evaluated. A supplementary analysis of a refueling incident inside the containment vessel is included. (M.L.S.)

39754 (DOCKET-50309-13) [MAINE YANKEE ATOMIC POWER STATION]. [Preliminary Safety Analysis Report], Amendment 11. (Maine Yankee Atomic Power Co., Wiscasset). June 24, 1968. 35p. Dep. CFSTI.

The chemical and volume control flow diagram for the Maine Yankee Power Reactor is given. Structural analyses and loading combinations for reactor internals are tabulated; a detailed discussion of the planned test and surveillance program for the containment systems is given. Activity released from hypothetical rod ejection incidents is tabulated; parameters used in analysis are included. Test procedures for determining concrete behavior during dowel-action resistance to earthquake shear are given; test results are tabulated. (M.L.S.)

39755 (DOCKET-50309-14) [MAINE YANKEE ATOMIC POWER STATION]. [Preliminary Safety Analysis Report], Amendment 13. (Maine Yankee Atomic Power Co., Wiscasset). July 16, 1968. 64p. Dep. CFSTI.

The financial qualifications of the Maine Yankee Atomic Power Company, owners of the Maine Yankee Power Reactor are given. The power contract and capital fund agreement among the eleven public utilities comprising the Maine Yankee Company are included; income statements for 1967 are tabulated. Estimates of capital costs for the Maine Yankee Power Reactor are given. Findings and opinion of the Securities and Exchange Commission are included. (M.L.S.)

39756 (DOCKET-50313-6) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, [Amendment 3] Suppl. 3. (Arkansas Power and Light Co., Little Rock). May 13, 1968. 365p. Dep. CFSTI.

General information concerning the overall design of the Russellville Power Reactor is given. The atmospheric diffusion model used for calculations for the Russellville site is evaluated. Environmental effects of hypothetical accidents are considered. Operation of engineered safeguards under post-accident conditions is discussed. Reactor protection and control system logic is described; actuation and control of the high and low pressure injection systems is discussed. Details of the radiation monitoring system are given. Emergency diesel generator leads are tabulated; guaranteed power supply systems are described. A classification of all seismic class I systems is given; construction codes and quality assurance criteria are indicated. A summary of emergency plans is given. Accumulated radiation doses are given for various plant locations. Thermal effects of Emergency Core Cooling System operation on the reactor and internals are evaluated. (M.L.S.)

39757 (DOCKET-50313-7) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, [Amendment 4] Suppl. 4. (Arkansas Power and Light Co., Little Rock). June 10, 1968. 229p. Dep. CFSTI.

Detailed information on the containment system and containment structure and liner for Russellville Power Reactor is given. Flood, tornado, and earthquake related factors are discussed. Structural design criteria are outlined. (M.L.S.)

39758 (DOCKET-50313-9) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, [Amendment 6] Suppl. 6. (Arkansas Power and Light Co., Little Rock). July 15, 1968. 83p. Dep. CFSTI.

An analysis of effects of the postulated design basis tornado on the spent fuel storage pool at the Russellville Power Reactor is given. (M.L.S.)

39759 (DOCKET-50315-7) DONALD C. COOK NUCLEAR PLANT. [Preliminary Safety Analysis Report], Amendment 3. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). June 28, 1968. 80p. (DOCKET-50316-7). Dep. CFSTI.

Information on the containment structure for Donald C. Cook Power Reactor, Units 1 and 2, is given; stress analyses for the structure are given; penetrations are described.((M.L.S.)

39760 (DOCKET-50317-5) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Baltimore Gas Electric Co., Md.). June 24, 1968. 131p. (DOCKET-50318-5). Dep. CFSTI.

Supplementary information on Calvert Cliffs Power Reactor, Units 1 and 2, is given on: Site and Environment including seismology and meteorology; Reactor Coolant System including design bases and coolant system flow diagram; Instrumentation and Control including reactor protection, initiation of engineered safeguards systems; secondary system control, nuclear instrumentation, nonnuclear process instrumentation, and communication; Electrical Systems including distribution system diagrams and emergency power; Auxiliary Systems including compressed air system; Waste Processing and Radiation Protection including waste processing and area radiation monitoring system; Safety Analysis including turbine generator overspeed accident and hypothetical accident analyses. (M.L.S.)

39761 (DOCKET-50322-1) SHOREHAM NUCLEAR POWER STATION, UNIT 1. LICENSE APPLICATION. (Long Island Lighting Co., Mineola, N. Y.). May 15, 1968. 40p. Dep. CFSTI.

The license application for Shoreham Power Reactor, Unit 1 is given. Financial qualifications of the Long Island Lighting Company are tabulated; the 1967 Annual Report is included. (M.L.S.)

39762 (DOCKET-50322-2) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 1. (Long Island Lighting Co., Mineola, N. Y.). May 15, 1968. 514p. Dep. CFSTI.

Information on the Shoreham Power Reactor, Unit 1 is given under the following main topics: Introduction and Summary; Site and Environs; Reactor Core; and Reactor Coolant System. (M.L.S.)

39763 (DOCKET-50322-3) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 2. (Long Island Lighting Co., Mineola, N. Y.). May 15, 1968. 493p. Dep. CFSTI.

Information on Shoreham Power Reactor, Unit 1, is given under the following main topics: Containment Systems including primary and secondary containment systems; Engineered Safeguards including Emergency Core Cooling Systems (ECCS), main steam line flow restrictors, control rod velocity limiters, control rod drive housing supports, and reactor standby liquid control systems; and Instrumentation and Control. (M.L.S.)

39764 (DOCKET-50322-4) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 3. (Long Island Lighting Co., Mineola, N. Y.). May 15, 1968. 478p. Dep. CFSTI.

Information on Shoreham Power Reactor, Unit 1, is given under the following major topics: Electrical Power System; Radioactive Waste Systems; Auxiliary Systems; Power Conversion Systems; Structures and Shielding; Station Operations; and Safety and Accident Analyses. (M.L.S.)

39765 (DOCKET-50322-5) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 4. (Long Island Lighting Co., Mineola, N. Y.). May 15, 1968. 307p. Dep. CFSTI.

Information on Shoreham Power Reactor, Unit 1, is given on the following topics: seismic analysis, core thermal design, control rod drive system, jet pump development program, core spray cooling test program, proposed outline for technical specifications, and design criteria comparison. (M.L.S.)

39766 (EUR-3079) EURATOM ECONOMIC HANDBOOK. Revised Edition. (European Atomic Energy Community). 1967. 92p. Dep. Euratom $3.00.

The merits of a nuclear power plant of a particular type as compared with others or with a fossil fuel plant are analyzed. The total power-generating cost of the plant is used as the criteria for analysis. Basic economic data relevant to the calculation of the nuclear power-generating cost and environmental factors are discussed. (D.C.C.)

39767 (EUR-3780) UTILIZZAZIONE DEL CALCOLATORE DELLA CENTRALE DEL GARIGLIANO PER L'ESECUZIONE AUTOMATICA DI ALCUNI CALCOLI RELATIVI ALL'ESERCIZIO DELL'IMPIANTO. (Use of the Garigliano Power Plant Computer for the Automation of Some Calculations Relating to the Operation of the Plant). Jovine, R.; Cammarota, U.; Cruciani, G. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1968. Contract 101-63-11 RDI. 106p. (In Italian). Dep.

The basic task of the computer installed at the Garigliano power plant is the direct collection and processing of data concerning the functioning of the plant. At the same time six new programs have been devised and perfected which process data fed into the computer as external "inputs" by means of tape. These programs have the following three aims: rapid execution of calculations relating to the processing of data resulting from measurements performed cyclically (wire irradiation); prompt examination of the results of a large number of measurements relating to non-routine operations performed during fuel loading and unloading or start-up periods (gamma scanning, half-line and temperature coefficient measurement, reactivity calculation); and statistical processing and functional correlation of any group of experimental data (general purpose programs, such as the polynomial interpretation of the law connecting two experimental variables (best fitting)). (auth)

39768 (EUR-3781) STUDI SUL CALCOLATORE ELABORATORE DEI DATI INSTALLATO PRESSO LA CENTRALE ELETTRONUCLEARE DEL GARIGLIANO. RELAZIONE FINALE. (Study on the Data-Processing Computer Installed by the Garigliano Nuclear Power Plant. Final Report). Cammarota, U.; Gangemi, F.; Jovine, R.; Santasilia, F. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1968. Contract 101-63-11 RDI. 28p. Dep.

A digital on-line process computer for the performance of calculations of various types, based on data obtained directly from the plant is described. The installation has three main aims, namely to study the possibility of using on-line process computers for calculations which previously were made only on large scientific computers, to have immediate processing of data during the special tests conducted under the R & D program, and to assess the usefulness of on-line computer to the operation of a nuclear plant. The experience acquired with the Garigliano computer, the results obtained, the operational reliability of the computer itself and the validity of the various computer codes adopted are presented. (auth)

39769 (EUR-3932) NEUTRON FLUX DISTRIBUTIONS DURING FIRST OPERATING CYCLE OF TRINO VERCELLESE REACTOR. Battista, G. P.; Valenziani, S. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar. 4, 1968. 128p. Dep.

The neutron flux distributions measured in the core of the Trino Vercellese Plant during the first core life by means of the incore instrumentation system called "Aeroball" are presented. The knowledge of the neutron flux distribution is expected to provide valuable assistance in connection with the planned increase in plant rating up to saturation of turbine capacity. The Aeroball system operation and the methods used in the data correction and analysis and associated errors are described. (auth)

39770 (GA-8204) GAPOTKIN: A POINT KINETICS CODE FOR THE UNIVAC 1108. Hansen, K. F.; Koch, P. K. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 25, 1967. Contract AT(04-3)-167. 50p. Dep. CFSTI.

GAPOTKIN is a point kinetics code that solves the space independent kinetics equations for a general form of the reactivity function. The code is written in FORTRAN IV language for the UNIVAC 1108 computer. (auth)

39771 (GA-8679) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending April 30, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). May 30, 1968. Contract AT(04-3)-314. 54p. Dep. CFSTI.

Development of a graphic reactivity handbook is described for on-site operational surveillance of short-term and long-term core reactivity during operation. The causes for the differences between anticipated and observed long-term reactivity changes with burnup are analyzed. Fuel element and reactor materials surveillance measurements are described for the 150 equivalent full-power day shutdown maintenance testing. Maintenance required for the reactor core is described. (D.C.C.)

39772 (GAMD-7909) TEMPERATURE AND POWER COEFFICIENT MEASUREMENT DURING RISE TO POWER IN PEACH BOTTOM (RESULTS OF POST CONSTRUCTION R AND D PROCEDURES DP-2, DP-3, DP-4, GP-2, AND GP-9). Brown, J. R.; Van Howe, K. R. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 11, 1968. Contract AT(04-3)-314. 15p. Dep. CFSTI.

Core reactivity changes resulting from changes in core temperature or in core power or combinations of both are presented for the Peach Bottom Power Reactor, Unit 1 during the rise to power program from January to June 1967. Core reactivity changes are determined from measured position changes of calibrated control rods; core temperatures are obtained from fuel element thermocouples; the helium flow rate and helium temperature are obtained from the standard plant instrumentation; and the core power is obtained from nuclear instrumentation calibrated by heat balance data. The measurements are compared with calculations. (auth)

39773 (IDO-17263) RELAP2: A DIGITAL PROGRAM FOR REACTOR BLOWDOWN AND POWER EXCURSION ANALYSIS. Moore, K. V.; Rettig, W. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 1968. Contract AT(10-1)-205. 75p. Dep. CFSTI.

RELAP2 is a FORTRAN IV digital program which calculates flow, mass inventories, temperatures, pressures, reactivities, and transient power for the primary system of a water reactor during a reactivity or a loss-of-coolant accident. Although retaining the simplified geometry (three volumes plus a core region) of the FLASH and RELAPSE programs, many improvements and extensions have been made. The geometry can be made to approximate either a pressurized or a boiling water reactor system. The core is treated as a two-point model for power generation, heat transfer, and reactivity feedbacks and as a one-point model for the reactor kinetics, pressure balances, and flow balances. RELAP2 is in production status on the CDC 6600, CDC 1604, IBM 7044, and Univac 1108. This version of the program has demonstrated more flexibility, greater stability, improved reliability, and a speed increase of over a factor of two when compared to RELAPSE. This version is not considered final since many improvements are being made in both the mathematical models and calculational techniques. Version 3, incorporating generalized geometry, trip logic, etc, is currently in the debugging status and should be released in the near future. Sample input and output formats are included. (auth)

39774 (IDO-17272) LOSS-OF-COOLANT ACCIDENT INVESTIGATIONS. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1968. Contract AT(10-1)-205. 163p. Dep. CFSTI.

REACTOR SAFETY—coolant loss accident analysis for, systems engineering approach to; coolant loss accidents, core response during; coolant loss accidents, primary system response during; coolant loss accidents, containment response during; engineered safeguards effects on coolant loss accidents; fuel pin temperature distribution during coolant loss accidents; blowdown effects on, subcooled and saturated; blowdown experiments for, description of; blowdown calculations for, description of models for

REACTORS, WATER COOLED—licensing process for, explanation of; coolant loss accidents in, systems engineering approach to; coolant loss accidents in, model for prediction of performance during; cooling system for, coolant loss accidents resulting from rupture of primary; coolant loss accidents in, effects of subcooled and saturated blowdown on; cores for, cooling during blowdown of; coolant loss accidents in, core heatup during; emergency core cooling for, effects on coolant loss accidents of; cores for, heat transfer models for; cores for, thermal-hydraulic analysis methods for

REACTORS, POWER—licensing process for, explanation of

REACTOR FUEL ELEMENTS—temperature distribution in pin-type, during coolant loss accidents; cladding temperature history during coolant loss accidents; cladding temperature dependence on core cooling during blowdown

REACTOR CONTAINMENT SYSTEMS—pressure history during coolant loss accidents; spray systems for, iodine-131 attenuation following coolant loss accidents using; pressure-temperature response during coolant loss accidents

IODINE—release to fuel rod plenum during blowdown, effects of temperature on

FISSION PRODUCTS—transport during coolant loss accidents; behavior in containment systems, description of program for

REACTOR SAFETY EXPERIMENTS—description of LOFT (M.L.S.)

39775 (IITRI-578-P-21-35) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report No. IITRI-J6133-19, October 1–November 30, 1967. Gallagher, E. V. (IIT Research Inst., Chicago, Ill.). Contract AT(11-1)-578. 21p. Dep. CFSTI.

Results of shock tube blowdown tests using twelve-foot-long driver sections are given. Effects of flow are analyzed; data are shown graphically. Driver cross section geometries are given. (M.L.S.)

39776 (JAERI-1154) USES OF PLUTONIUM FUEL IN PRESSURE TUBE-TYPE, HEAVY-WATER MODERATED THERMAL REACTORS. Yasukawa, Sigeru; Shindo, Ryuiti (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Dec. 1967. 7p. Dep.

Feasibility studies of the use of plutonium fuel in the pressure-tube-type heavy-water moderated thermal reactors are described. Burnup characteristics of plutonium-fueled lattices are discussed; self-sustaining cycles are tabulated as a function of lattice pitch. Fuel cycle cost is considered. 15 references. (M.L.S.)

39777 (JAERI-1159) THREE DIMENSIONAL NUCLEAR THERMAL-HYDRAULIC CHARACTERISTIC ANALYSIS OF JPDR CORE. Shimooke, Takanori (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jan. 1968. 39p. (In Japanese). Dep.

Nuclear thermal-hydraulic characteristics of the JPDR core have been calculated by the three dimensional nuclear thermal-hydraulic code "FLARE". The results are consistent with the measurement results in the JPDR core. Accuracies of the FLARE model are as follows: ±0.4% in reactivity; about ±2.8 MW(t) in thermal power at the rated power-45 MW(t); within 3% of standard deviation in the channel power ratio; and gross peaking factors acceptable for core safety analyses with sufficient confidence, if 5% in maximum is added to the values. Many calculation results under the various reactor operation conditions are shown and it becomes clear that the design values of the JPDR core have sufficient margin. Flux distributions in the core are also reported as a function of the reactor power and rod patterns. The experimental investigation of the validity of the FLARE model from the general viewpoint is described. (auth)

39778 (JUL-518-RG) TEIL I. EXPERIMENTELLE BESTIMMUNG DES EINFLUSSES VON HOHLRAEUMEN IN MODERATORMATERIALIEN AUF DIE DIFFUSIONSKONSTANTE THERMISCHER NEUTRONEN MIT HILFE DER METHODE DER GEPULSTEN QUELLEN. TEIL II. AUSWERTUNG VON EXPERIMENTEN ZUM DIFFUSIONSKUEHLUNGSEFFEKT NACH DER METHODE VON WILLERS. (Part I. Experimental Determination of the Influence of Cavities in Moderator Material on the Diffusion Constant of Thermal Neutrons with the Help of the Method of Pulsed Sources. Part II. Evaluation of Experiments on the Diffusion Cooling Effect by the Willers Method). Della Loggia, E.; Hecker, R.; Stoever, D.; Babac, T.; Breitbarth, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Feb. 1968. 89p. (In German). Dep.

The experimental determination, using pulsed source methods, of moderator void effects on thermal reactors is described. Methods used to calculate geometric bucklings and diffusion parameters are outlined. The experimental apparatus is described; the experimental procedure for void measurements is given. Measurements using plexiglas systems are described. All data are tabulated. A method for development of an approximate function for the neutron source term is given; this model is based on the pulsed neutron techniques. A computer program, DIFKUL, for cal-

culation of the diffusion parameters is detailed. A program listing is included. 27 references. (M.L.S.)

39779 (JUL-519-RG) KONZEPTSTUDIE FUER EINEN HOCHTEMPERATUR-KUGELHAUFENREAKTOR 1200 MW_{el}. (Conceptual Studies for a High-Temperature Pebble Bed Reactor of 1200 MW_{el}). Kersting, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Feb. 1968. 142p. (In German). Dep.

A conceptual design for a high temperature pebble bed reactor is given. The pebble fuel element and cooling medium are described; the role of a pilot plant and the thorium high temperature reactor is discussed. A short description of the general layout is given. Design parameters for the core, primary circuit, reactor vessel, and secondary circuit are included. Thermodynamic calculations are detailed. Safety aspects are considered briefly. A cost analysis is given. 29 references. (M.L.S.)

39780 (KFK-656) DIE STABILITAET VON STARR ZURUECKGEFUEHRTEN REGELSTRECKEN OHNE AUSGLEICH AM BEISPIEL DES DAMPFGEKUEHLTEN REAKTORS. (The Stability of Rigid Feedback Control Systems without Compensation in an Example of a Steam Cooled Reactor). Krebs, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Dec. 1967. 27p. (In German). (EUR-3691). Dep.

The development of a calculational model for a steam cooled reactor system is discussed. Approximation methods for calculation of stability limits are developed; models with and without the dead time are considered. Time lag effects are analyzed; the importance of criticality factors is evaluated. Stability limits for a steam-cooled reactor coolant circuit are determined. (M.L.S.)

39781 (MIT-2073-8) SUMMARY DESCRIPTION OF THE FUEL DEPLETION CODE, CELL. Goeliner, D. A.; Beaudreau, J. J. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). June 30, 1968. Contract AT(30-1)-2073. 66p. (MITNE-89). Dep. CFSTI.

The CELL code performs a modified-two group, point-depletion calculation and determines the characteristics of a unit reactor cell as functions of thermal flux-time. These characteristics are prepared by CELL in a form suitable for use by the fuel management code MOVE, which carries out reactivity and spatial flux calculations throughout core life and simulates various refueling schemes. Using the earlier FUEL code as a starting point, CELL was developed to provide a means for accurately predicting the fuel cycle performance of water-moderated reactors, while retaining a level of sophistication consistent with the requirement of low computer time usage and without introducing any changes to MOVE. The major differences between the CELL and FUEL codes are discussed, and a comparison is made of the accuracy with which the two codes predict the experimentally-determined variations of fuel isotopic composition with burnup for the Yankee Reactor. First cycle characteristics predicted by CELL-MOVE for the San Onofre pressurized-water reactor are compared with Westinghouse calculations. Conclusions are drawn concerning the ability of CELL to accurately predict PWR fuel cycle characteristics. The theory and assumptions included in CELL are discussed. All principal equations are given and a broad logical flow diagram of the code is presented. (auth)

39782 (N-68-20355) ACTIVATION OF SODIUM, LITHIUM, AND POTASSIUM IN COMPACT FAST REACTORS AND ITS EFFECT ON SHIELDING. Soffer, Leonard (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 23p. (NASA-TM-X-1512). CFSTI.

Neutron activation of sodium (Na), lithium (Li), and potassium (K) used as possible coolants in a "typical" compact fast reactor is analytically investigated. The natural elements, all individual isotopes, and one common eutectic (NaK 78) are examined. Suitable energy dependent neutron fluxes are used in conjunction with activation cross sections to calculate saturated specific activities. Activation cross-section data for the elements studied are compiled and tabulated, and these data are judged to be adequate for engineering calculations. Results show that when zero holdup time is assumed, the best coolants on the basis of unshielded activation dose rate, are ^{40}K, ^{39}K, ^{7}Li, and natural Li. The worst are ^{41}K and Na. Because of low natural abundance, ^{40}K is impractical as a reactor coolant. Lithium dose rates are very sensitive to holdup time because of the short (0.8 sec) half-lives of the Li products. Holdup of even a few seconds greatly reduces the Li dose rates but not those for any other element. Lithium 7 held up for 8 seconds and gave the lowest activation dose rate of any coolant considered. The unshielded dose rate from the assumed fission product release was the highest of all. It was about two orders of magnitude greater than the zero-holdup ^{7}Li rate, and about five orders of magnitude greater than the dose rate for ^{7}Li held up for 8 seconds. Gas evolution resulting from coolant irradiation was also investigated and found to be negligible except for ^{6}Li. (auth) (STAR)

39783 (NUMEC-3432-32) IRRADIATION TESTING OF PuO_2-UO_2 FUELS. Quarterly Progress Report, January 1-March 31, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). May 1968. Contract AT(30-1)-3432. 7p. Dep. CFSTI.

Evaluation of the performance of fuel elements from coprecipitated PuO_2-UO_2 and pellets prepared by mechanical mixing of the component powders is presented. The effects of stoichiometry, fabrication, and W_2C coatings on the mechanical properties of the stainless steel-clad fuel capsules after 20,000 MWD/T irradiation are described. (D.C.C.)

39784 (RT/FIMA-(68)-1) DINPEC: PROGRAMMA IBM-7094 PER IL CALCOLO DI TRANSITORI DI POTENZA E DI PORTATA IN UN REATTORE NUCLEARE. (DINPEC: IBM-7094 Program for the Calculation of Transitory Power and Rate in a Nuclear Reactor). Amelotti, F.; Azzoni, P.; De Cecco, L.; Casadei, G.; Fucci, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 48p. (In Italian). Dep.

A computer program, DINPEC, for calculation of temperature and power distribution in a reactor core is given. The kinetics equations and assumptions for the numerical solutions are outlined; heat balance equations are developed. The flow diagram is shown; a tabulated program description is given. Sample computer inputs and outputs are included. (M.L.S.)

39785 (SRARI-P-4) K VOPROSU O KRITERIYAKH EFFEKTIVNOSTI AES NA BYSTRYKH NEITRONAKH. (Regarding the Question of the Criteria for Efficiency of an Atomic Power Station with Fast Neutrons). Kazachkovskii, O. D.; Kirillov, E. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1967. 17p. (In Russian). Dep.

Considered are efficiency criteria of fast power reactors: reproduction factor, thermal efficiency, doubling time, and electric energy cost. The role of each criterion is demonstrated for fast reactor economics. The conclusion is made that only the total electric energy production costs can be the final and complete efficiency criterion. (auth)

39786 (TID-24530) CONCEPTUAL DESIGN OF A BOILING WATER REACTOR PLANT TO RESIST GROUND FAULT DISPLACEMENT. Kummerle, E. R. (Burns and Roe, Inc., Oradell, N. J.). May 1968. Contract W-7405-eng-26; Subcontract WO-2582-01. 117p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

A conceptual design for an earthquake-resistant boiling water reactor (BWR) is given. The 1000 MWe plant is of the Browns Ferry type with the reactor building floating in a viscous fluid; a complete description of the fluid is given. Dynamic response of the entire reactor system is calculated for various earthquake loadings. Descriptions of the various BWR systems and components are given. Cost estimates and feasibility analyses are included. The limitations of current reactor designs under earthquake loadings are analysed in detail; motion equations are developed. (M.L.S.)

39787 (TID-24558) A FLOATING EARTHQUAKE-RESISTANT NUCLEAR POWER STATION. Report No. 182-1-1. (Daniel, Mann, Johnson, and Mendenhall, Los Angeles, Calif.). Apr. 1968. Contract W-7405-eng-26; Subcontract 2962. 260p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

A concept is presented for a 1000 MWe floating nuclear power station. This concept is developed as an alternate to land-based power reactors in areas of high earthquake probability. The design of the barge, which will float the entire power station, is detailed; economic factors are evaluated. The power plant design is given. Environmental protection for the plant is detailed; this includes: wind-generated water waves, mooring system, local earthquake, Tsunamis, marine growth, and sand transport and basin silting. Appendices include: alternate barge designs, a floating wave damper, an arrangement of chambers to protect floating stations, feasibility study on some oceanographic and hydrodynamic problems, and calculations for response of barge to vertical ground motion. (M.L.S.)

39788 (TUBIK-7) VERFUEGBARKEITSBESTIMMUNG VON KERNKRAFTWERKEN. (Determination of Availability of Nuclear Power Stations). Renk, K.-D. (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Dec. 1967. 94p. (In German). Dep.

Breakdown or failure of 40 world nuclear power plants is tabulated; data are tabulated according to reactor type with design features and other salient points being given. Histograms showing

failure causes and reliability are shown. Unplanned shutdowns and down time are given. Functional analyses of the various nuclear power plant systems are given; both block diagrams and descriptions are included. Cost estimates for failures or unintentional shutdowns are given. 18 references. (M.L.S.)

39789 (UNC-5198) POST-IRRADIATION EXAMINATION OF HIGH-DENSITY (UPu)C PELLET-FUELED EBR-II RODS IRRADIATED TO 30,000 Mwd/T. Stahl, D.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Jan. 24, 1968. Contract AT(30-1)-3415. 53p. Dep. CFSTI.

EXPERIMENTAL BREEDER REACTOR-II—fuel element irradiation operations in, description of metal-clad helium-bonded plutonium carbide (PuC)–uranium carbide (UC)
REACTOR FUEL ELEMENTS—radiation effects on physical properties of metal-clad helium-bonded plutonium carbide (PuC)–uranium carbide (UC) pellet-type, analysis of fast neutron
NEUTRONS, FAST—effects on physical properties of metal-clad helium-bonded plutonium carbide (PuC)–uranium carbide (UC) pellet-type fuel elements, analysis of
RADIATION TARGET CANS—configuration of EBR-2, for metal-clad helium-bonded plutonium carbide (PuC)–uranium carbide (UC) pellet-type fuel elements
URANIUM CARBIDES—PuC–UC, radiation effects on physical properties of metal-clad helium-bonded, analysis of fast neutron
VANADIUM ALLOYS AND SYSTEMS—Ti–V, radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of, analysis of fast neutron
VANADIUM—radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of, analysis of fast neutron
STAINLESS STEEL—radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of Type 316, analysis of fast neutron (D.C.C.)

39790 (UNC-5201) FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM. Second Quarterly Progress Report, October–December 1967. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Feb. 10, 1968. Contract AT(30-1)-3415. 41p. Dep. CFSTI.

EXPERIMENTAL BREEDER REACTOR-II—fuel element irradiation operations during October to December 1967, description of plutonium carbide (PuC)–uranium carbide (UC)
REACTOR FUEL ELEMENTS—radiation effects on physical properties of metal-clad plutonium carbide (PuC)–uranium carbide (UC) pellet-type, analysis of fast neutron; compatibility of liquid sodium-bonded metal-clad plutonium carbide (PuC)–uranium carbide (UC), analysis of
NEUTRONS, FAST—effects on physical properties of metal-clad plutonium carbide (PuC)–uranium carbide (UC) pellet-type fuel elements, analysis of
URANIUM CARBIDES—PuC–UC, radiation effects on physical properties of metal-clad, analysis of fast neutron; PuC–UC, fuel element fabrication of, quality control in pellet-type; PuC–UC, fuel element compatibility for liquid sodium-bonded, analysis of metal-clad
VANADIUM ALLOYS AND SYSTEMS—Ti–V, radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of, analysis of fast neutron
VANADIUM—radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of, analysis of fast neutron
STAINLESS STEEL—radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of Type 316, analysis of fast neutron
INCOLOY 800—radiation effects on physical properties of plutonium carbide (PuC)–uranium carbide (UC) fuel cladding of, analysis of fast neutron
SODIUM—fuel bonding of liquid, fabrication of plutonium carbide (PuC)–uranium carbide (UC) (D.C.C.)

39791 (WAPD-296) PWR CORE 2 REACTOR DESIGN DESCRIPTION REPORT. Atherton, R.; Kikta, E. J.; Sherman, J. (eds.) (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1968. Contract AT(11-1)-Gen-14. 143p. Dep. CFSTI.

The significant design features of Shippingport Core 2 are described. The core mechanical and fuel element characteristics are discussed. A brief description of the Shippingport reactor plant is also provided, with emphasis on those plant changes required to permit reactor operation at 505 Mw(t). (auth)

39792 (WAPD-PWR-TE-207) SHIPPINGPORT PWR FLUX WIRE MEASUREMENTS FROM BEGINNING OF LIFE THROUGH 5900 EFFECTIVE FULL POWER HOURS OF OPERATION OF THE FIRST SEED OF THE SECOND CORE: TEST EVALUATION. Crawford, John A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Dec. 1967. Contract AT-11-1-GEN-14. 76p. Dep. CFSTI.

Activation distributions have been measured in the first seed of the second core of the Shippingport Pressurized-Water Reactor for various core xenon conditions. An evaluation of the experimental activation data obtained from beginning-of-life through the first approximately 5900 effective full power hours of operation is given. Comparisons of the experimental data to results obtained from nuclear design calculations are presented; an evaluation of these comparisons is made. In general, the agreement of the calculations with the experimental radial and axial distributions is considered good for all core xenon conditions. In particular, it is shown that the relative radial flux distributions are generally calculated by the nuclear design models within the expected range of 5 to 10%, as are the axial flux distributions in the important reactivity worth and power producing region in the vicinity of the axial flux peaks. Also included is a description of the flux wire system and its use in obtaining experimental activation distributions. (auth)

39793 (WCAP-3269-64) THE EFFECT OF HIGH POWER DENSITY ON UO_2 ROD TYPE ELEMENTS: THE SAXTON SPECIAL 2 X 2 ASSEMBLY. Rolin, John; McClintock, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 1967. Contract AT(30-1)-3269. 42p. Dep. CFSTI.

Four stainless steel clad UO_2 fuel elements were irradiated to a peak power density of 23 kW/ft and a peak burnup of 12,000 MWD/MTU in the Saxton Reactor. Uranium dioxide fuels at 97- and 78-percent initial theoretical density were represented. Post-irradiation destructive examination of the fuel elements included fission gas analysis, ^{137}Cs nuclide burnup analysis, and microstructural examination of the fuel. The performance of these high power density fuel elements was satisfactory. (auth)

39794 HEAT EXTRACTION COMPONENTS FOR SODIUM-COOLED FAST REACTORS. De Haas van Dorsser, A. H. (Centraal Technisch Instituut TNO, Delft, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 25, 95-105(1968). (In Dutch).

Detailed literature study and calculations were made to achieve a design for a steam generator in which hot liquid Na is used to produce steam. Single-wall tubes with a length of 20 m are chosen; the Na circulates outside. Experiments are performed to determine which temperature ferritic steel can be combined with austenitic steel in components where Na is in contact. The solutions that are possible for temperatures exceeding the permissible temperature, are discussed. Experiments on thermal shocks are also in progress. (J.J.t B.)

39795 THE CONSTRUCTION OF THE GKN-REACTOR. Wassenaar, K. (Gemeenschappelijke Kernenergiecentrale Nederland, Dodewaard, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 25, 9-26(1968). (In Dutch).

The construction of the reactor vessel, reactor chamber, and pressure suppression system of the boiling water power reactor at Dodewaard, The Netherlands, is described. Special attention is given to the problems associated with the transition of pipes and cables through vessel walls. The reactor control rods are operated through the reactor vessel bottom; the steam exit is at the top. The pressure suppression system is calculated to withstand pressures arising from breakage of the main steam line. Steam then expanding into the reactor chamber may reach a pressure of 60 psia before it is condensed into water. (J.J.t B.)

39796 CIRCUIT LAYOUT OF HELIUM TURBINE DESIGN WITH A NUCLEAR REACTOR AS HEAT SOURCE. Gasparovic, Nebojsa. Forsch. Ingenieurw., 34: No. 2, 33-9(1968). (In German).

Design parameters for the intermediate cooling circuit for a gas cooled reactor are given. Choice of optimization parameters is discussed. Effects of reactor inlet temperature, coolant inlet temperature, gas turbine design efficiency, and compressor pressure dependence are evaluated; results are shown graphically. Specific entropy of the system is shown as a function of centigrade temperature. Effects of turbine entrance temperature are detailed; volume equivalents for the turbine and compressors are shown. (M.L.S.)

39797 PRESSURE VESSELS AND CORE SUPPORT CONSTRUCTIONS OF LIGHT-WATER REACTORS. Van Veen, M. C. (Rotterdamsche Droogdok Maatschappij, Rotterdam). RCN (Reactor Cent. Ned.) Meded., No. 25, 27-39(1968). (In Dutch).

Experience in the construction of components of nuclear reactors is described. Several reactor vessels have been constructed with forged stainless steel rings. Steel plates with a thickness up to 200 mm can be welded to the quality standards required in nuclear engineering. Special attention is paid to the choice between

forging and welding in the fabrication of large components. (J.J.t B)

39798 NON-DESTRUCTIVE CONTROLS OF MANUFACTURE ON FINNED SHEATH TUBES FOR ORGEL TYPE NUCLEAR COMBUSTIBLE ELEMENTS. Robba, M.; Martelli, C. (ISML, Novara, Italy). Met. Ital., 60: 293-307(Apr. 1968). (In Italian).

The ultra-sounds technique with internal probes, which has been developed to examine the defects of finned tubes, is described. The presence of the external finning prevents examination of tubes from the outside, while the internal probes, which are described, allow the detection of the longitudinal defects (provided that they are near the internal surface) as well as of the transversal defects (in any point of the thickness of the walls). A metallographical study has been started aiming at establishing a correlation between the signals of defect produced by the ultra-sounds and the nature and importance of these defects: the results obtained are described. (auth)

39799 NUCLEAR REACTOR PLANT. (to Sulzer Brothers Ltd.). British Patent 1,119,169. July 10, 1968. Priority date Nov. 1, 1965, Switzerland.

A description of a gas-liquid heat exchange system for a nuclear reactor is presented. The tube bank heat exchangers consist of multiple tube panels in parallel. Each panel is a self-supporting ladder of parallel tubular rungs connecting two vertical tubular stringers. The stringers are subdivided by transverse walls to form flow chambers for side-to-side flow through successive rungs. (D.C.C.)

39800 FUEL CHARGING INSTALLATION FOR A NUCLEAR REACTOR. Costes, Didier (to Commissariat a l'Energie Atomique). British Patent 1,117,265. June 19, 1968. Priority date Oct. 8, 1965, France.

A description of a fuel element loading machine for a liquid Na-cooled fast reactor is presented. The loading machine consists of a horizontal beam which penetrates the pressure vessel beneath the core area. The beam pivots horizontally and has a transverse device for receiving fuel elements. Fuel elements are lowered from the core to the loading machine. The horizontal loading machine retracts to a vertical access opening where the fuel element is removed. A vertical access opening over the core provides a loading port. (D.C.C.)

39801 HANDLING FACILITY FOR A NUCLEAR REACTOR FUEL RECHARGING INSTALLATION. Robin, Marcel; Vautrey, Louis (to Commissariat a l'Energie Atomique). British Patent 1,119,426. July 10, 1968. Priority date May 16, 1966, France.

A description of a fuel loading machine for a liquid Na-cooled fast nuclear reactor is presented. The loading machine consists of a main bearing beam, a turntable rotated around a vertical axis, a main carriage which is movable on the turntable, and a connected arm and grippers. The arm is folded along the turntable when the loading machine is introduced or withdrawn from the core vessel. The loading machine is externally driven and enters the core vessel by a hermetic door. (D.C.C.)

39802 NUCLEAR REACTORS. Martin, Hugh Allan (to United Kingdom Atomic Energy Authority). British Patent 1,117,315. June 19, 1968. Filed Dec. 14, 1964.

A description of a water-cooled reactor liquid control system is presented. The control fluid is contained in flat slab-like compartments which extend parallel to coolant flow direction. The reactor consists of a square lattice of double wall fuel channels. The control fluid occupies the interior compartments. Control is maintained by pumping in control fluid or a purging fluid. (D.C.C.)

39803 FAST NUCLEAR REACTOR. (to Hitachi Ltd.). British Patent 1,117,165. June 19, 1968. Priority date May 24, 1965, Japan.

A description of the core region of a liquid Na-cooled fast reactor is presented. The multi-zone core consists primarily of a $^{238}U-^{239}Pu$ fuel cycle arrangement with concentric regions of $^{238}U-^{235}U$, $^{238}U-^{233}U$, $^{232}Th-^{239}Pu$, $^{232}Th-^{235}U$, or $^{232}Th-^{233}U$ fuel cycles. The fuel arrangement serves to stabilize the coolant void reactivity regions. (D.C.C.)

39804 IMPROVEMENTS IN NUCLEAR REACTORS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,117,100. June 12, 1968. Priority date Oct. 23, 1964, Sweden.

A description of a cooling system for a boiling heavy water-cooled and heavy water-moderated reactor is presented. The moderator tank is enclosed in the pressure vessel. Tube connections allow heavy water steam to circulate in the moderator tank directly from the pressure vessel. The moderator tank is separately steam-cooled, and the condensed coolant is used for the reactor coolant. The tube connection of pressure vessel and moderator tank serves as a pressure control system. (D.C.C.)

39805 NUCLEAR POWER DEVELOPMENT IN THE USSR. Sinov, N. M. (Inst. of Atomic Energy, Moscow). Jad. Energ., 14: 41-6(Feb. 1968). (In Czech).

A brief review is given on the development of nuclear power, construction, operation, and performance of nuclear power plants, and aspects of future development. Descriptions are given of the first nuclear power plant in Obninsk and the power reactors with graphite moderator and pressurized water, boiling water, and steam coolants (Siberian, Beloyarsk, and Bilibinsk reactors), water–water reactors cooled under pressure and boiling water (Voronezh and Melekess), and fast reactors programmed for Melekess (BOR-60) and Shevchenko (BN-350). Economic aspects of power reactors are discussed. (tr-auth)

39806 RECENT REVIEW AND FUTURE PROSPECTS OF NUCLEAR POWER STATIONS EQUIPPED WITH FAST BREEDER REACTORS. Sinov, N. M. Jad. Energ., 14: 46-52(Feb. 1968). (In Czech).

Data of the development of Soviet fast reactors and aspects of their use in power plants are given. Various steps in achieving the reactor program are analyzed and descriptions are given of the BR-5, BN-350, and BOR-60 reactors and their performance. (tr-auth)

39807 DEVELOPMENT OF WATER-COOLED REACTORS FOR POWER PLANTS IN THE USSR. Skvorcov, S. A. (Moscow Inst. of Atomic Energy). Jad. Energ., 14: 52-6(Feb. 1968). (In Czech).

A brief review is given of technical and economic aspects of water-cooled reactors of the VVER type (VVER-210, VVER-365, VVER-440, VVER-500, and VVER-1000) and of their future development. (tr-auth)

39808 ANALYTIC DETERMINATION OF LOSS OF COOLANT IN BHWR. Zdravkovic, Momcilo (Univ., Belgrade). Tehnika (Belgrade), 23: No. 1, 24b-f(Jan. 1968). (In Slavic).

An analytical procedure for accident analysis of boiling heavy-water reactors is given. The technique of dimensional analysis is used for blowdown and water hammer evaluation in the event of loss of coolant. The integral equations are solved in closed form assuming weightless liquid discharge. Solutions are obtained for two different flow cross sections for the reactor vessel. (M.L.S.)

39809 ARRIVAL OF NUCLEAR POWER. Hogerton, John F. Sci. Amer., 218: No. 2, 21-31(Feb. 1968).

The development of nuclear power stations in the United States is reviewed. Present nuclear power station programs are described. Forecasts of nuclear power generating capacity and effects of fossil fuel competition are presented. (D.C.C.)

39810 INTRODUCTORY SURVEY OF BASIC DESIGN AND FUEL-ELEMENT CONSIDERATIONS FOR LARGE, FAST SODIUM-COOLED REACTORS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design, 7: 399-410(May 1968).

Some basic design and fuel element considerations in the development of large, fast breeder power reactors are analyzed on the basis of experimental and calculated results. Nuclear safety and stability, breeding, and economy are three principal requirements for developing large, fast power reactors. For nuclear safety and stability, the Doppler reactivity effect, sodium void (or loss) reactivity effect and structural expansion reactivity effect are analyzed. For breeding, the breeding ratio and gain, and the doubling time of fuel production are presented. Thermal and structural considerations of fuel element design are outlined. For economy, as well as breeding, the development of a ceramic (especially carbide) plutonium fuel system with higher power density and specific power for the large, fast power reactor system is desirable. (auth)

39811 SODIUM BOILING TRANSIENTS IN OXIDE-FUELED FAST REACTORS. MacFarlane, D. R.; McNeal, N. A.; Meneley, D. A.; Sanathanan, C. K. (Argonne National Lab., Ill.). Nucl. Eng. Design, 7: 411-26(May 1968).

Methods and results of a theoretical investigation of the dynamic response of large oxide-fueled fast reactor cores during transient over-power or under-flow situations which result in bulk boiling of the coolant are presented. The validity of the analysis is restricted to the regime before the cladding melts or fails otherwise; that is, before material motion other than that due to thermal expansion is experienced. The model and computational scheme for predicting coolant boiling (sodium voiding) behavior, has been incorporated into a closed loop calculation which includes reactor kinetics with sodium voiding and Doppler reactivity feedbacks. The results of calculations for power increase (reactivity ramp) transients for two cores with different geometry are presented

and compared. Results of calculations for a flow coastdown transient are also presented and discussed. Some of the limitations of the model and method are also discussed briefly. (auth)

39812 PRIMARY PIPING FLEXIBILITY ANALYSIS FOR LIQUID-METAL-COOLED FAST BREEDER REACTORS. McKeon, James T. (Kellogg Co., Jersey City, N. Y.). Nucl. Eng. Design, 7: 427-41(May 1968).

Discussion of the four main problem areas in the design and analysis of primary piping for liquid-metal-cooled fast breeder power reactor systems includes: validity of the "stress range" concept; local overstrain and creep concentrations; thermal ratchetting; and elastic and inelastic buckling. Examination of the applicability of present design methods to rigid piping systems (in which the thermal expansion is absorbed by the inherent flexibility of piping components) and to non-rigid piping systems (in which the thermal expansion is accommodated by bellow joints), and criticism of present design rules are discussed. (auth)

39813 SUMMARY AND ANALYSIS OF TREAT SODIUM LOOP EXPERIMENTS ON BEHAVIOR OF SINGLE EBR-II MARK I PINS UNDER ACCIDENT CONDITIONS. Dickerman, C. E.; Purviance, R.; Robinson, L. E.; Stephany, W.; Willis, F. F. (Argonne National Lab., Ill.). Nucl. Eng. Design, 7: 442-54(May 1968).

The study of fast reactor safety is concerned with a number of areas, among which the possibility of core meltdown is of major interest. A number of factors might be involved in such an accident; a study, experimentally and by computation, of the mechanisms of fuel failure and associated movement of fuel and coolant is described. These two phenomena could lead to extension of any initial fuel failure and thus would probably be the factors responsible for a serious meltdown accident. Fuel failure experiments have been conducted in instrumented sodium loops, which, when installed in the TREAT reactor, provide a simulated reactor environment. These loops provide for setting conditions of varying temperature and flow of sodium coolant past the fuel elements under test; and the power burst of the TREAT reactor, into which the loops are inserted for testing, can be adjusted to specified intensities. The results of testing a number of sample fuel elements under various conditions of power level and coolant flow are presented. (auth)

39814 DO PRESENT NUCLEAR POWER STATIONS MAKE POOR USE OF FUEL? Eitz, A. W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 13: 286-7(June 1968). (In German).

Among the arguments which are still advanced today in the German Federal Republic against the introduction of nuclear energy for the large-scale generation of electricity is the allegation that reactor types which are at present economic make poor use of the nuclear fuel and will therefore result in an early exhaustion of U reserves. The problem of the optimum utilization of U deposits cannot however be considered exclusively in terms of the exhaustion of reserves. An increased U demand will result first of all in an increase in the price of U. Nuclear power stations which are not competitive at the higher U prices will automatically be eliminated from the market. Reactor types which could cope economically with the higher U prices cannot be condemned because of insufficient utilization of fuel. Thermal reactors, it is true, have a higher U demand than breeder reactors but they are necessary for the production of Pu. Reactors which attain the energy-economical aim of a low U demand must at the same time also be able to generate power at competitive prices. Only then can it be expected that they will supercede other reactor types which are less suitable on a basis of energy-economy. (auth)

39815 LICENSING PROCEDURE FOR NUCLEAR POWER STATIONS ACCORDING TO THE ATOMIC LAW OF THE U. S. A. Henrichs, H. Atomwirt., Atomtech., 13: 288-91(June 1968). (In German).

Discussion about a change in the German regulations for the licensing of nuclear power stations has been going on for some time. A look at how these problems are handled in the U. S. A. where the legal situation is comparable can provide pointers and suggestions for this discussion because of the longer experience and the growing number of such proceedings there. In the U. S. A., the relevant regulations have in the course of time been supplemented and adjusted according to the exigencies of practice. The American applicant for a license is able to begin construction at an earlier stage of the overall planning because of the basic division of the licensing process into a construction licensing and an operating licensing and because of the possibility of obtaining provisional licensing or an interim decision for certain parts. This of course carries a risk that the whole investment will prove futile if final approval of the nuclear power station is not obtained from the USAEC. This risk is only partially removed by the fact that the applicant can elicit certain binding decisions from the AEC in a continuous process. In practice it is particularly important that this risk can be assessed and, by alterations, limited through a continuous contact with the AEC. In addition it is then possible in a legal way to utilize experience gained during the construction in the same undertaking. The objections which have been raised against this procedure in the U. S. A. on the part of industry concern the size of the investment risk and in public the danger that the AEC will be tempted to relax the safety requirements under pressure of this risk. Both objections have so far proved without foundation. (auth)

39816 METHOD FOR REDUCING FOULING ON SURFACES COMING INTO CONTACT WITH ORGANIC COOLING AND/OR MODERATOR FLUIDS. Van Rutten, Fernand; Hoepper, Meinolf; Diletti, Friedhelm (to EURATOM). U. S. Patent 3,377,253. Apr. 9, 1968. Priority date Dec. 9, 1965, Netherlands.

Fouling on metal surfaces coming into contact with hot organic, terphenyl containing coolant used in a nuclear reactor is greatly reduced by filtration of the coolant over graphite, preferably at the operating temperature of the reactor. (Offic. Gaz.)

39817 NUCLEAR REACTOR GAS-TURBINE PLANT WITH EMERGENCY COOLING. Spillmann, Werner (to Escher Wyss Aktiengesellschaft). U. S. Patent 3,377,800. Apr. 16, 1968. Priority date Aug. 12, 1965, Switzerland.

A gas-turbine power plant is described in which the working medium is heated directly in a nuclear reactor. The power plant includes a two-part cooler which is located in the working medium circuit, and an emergency cooling conduit which branches off said circuit between the two cooler parts and returns to the circuit at a point between the reactor and the compressor. This conduit contains a cooling blower and a shut-off valve, and a second shut-off valve is provided in the working medium circuit between the return point of the cooling conduit and the compressor. (Offic. Gaz.)

39818 NUCLEAR POWER IN THE PACIFIC NORTHWEST: WHEN? Monks, Joseph G. (Univ. of Washington, Seattle). Bus. Rev., Univ., Wash., 25: No. 3, 44-60(Feb. 1966).

Topics discussed include: nuclear economic feasibility; the Pacific Northwest situation; power costs in the Pacific Northwest; projected power requirements for year 2000; power resources including hydroelectric plants; nuclear plants in the Pacific Northwest; and Canadian treaty and California intertie. (D.C.C.)

39819 CONTROL OF A NUCLEAR REACTOR: MEASUREMENT OF TRANSFER FUNCTIONS. Dang Van Ba, M.; Roch, A. Bull. Tech. Suisse Romande, 93: 335-9[1967]. (In French).

The control system of a nuclear reactor uses the measure of the neutron flux existing in the core of the reactor, also a larger derivation of this measure, namely the period. Independently of the fact that the instrument measures the flux in a rather arbitrary place, the measures are degraded by proven errors consisting of information delays in the transfer functions of the instrument itself. The transfer functions can be evaluated using simulation techniques on an analogue computer. (UK)

39820 MOMENT OF TRUTH FOR HIGH-TEMPERATURE REACTORS. De Bacci, Mario; Marien, Pierre (EURATOM, Geel, Belg.). Euratom Rev., 7: 42-5(June 1968).

The outlook for the large-scale industrial application of high-temperature gas cooled reactors is examined in the light of the present state of development. Design and performance characteristics of the Dragon, Peach Bottom, and AVR reactors are reviewed, and the development potential of high-temperature reactors using thorium fuel cycles and gas turbines is discussed. (H.D.R.)

39821 GAS TURBINES FOR NUCLEAR POWER PLANTS. Boehm, Edgar (Gutehoffnungshuette, Oberhausen, Ger.). Euratom Rev., 7: 52-8(June 1968).

The advantages offered by incorporating a closed gas turbine cycle in a high-temperature gas cooled power reactor are discussed. Recent development work on closed-cycle gas turbines is reviewed, and design and performance characteristics of He turbines are examined. Plant layouts for large high-temperature reactors with He turbines are illustrated for both conventional and integrated designs. Performance data are presented for a 1000 MW(e) plant with He turbine. (H.D.R.)

39822 STATE OF DEVELOPMENT OF NUCLEAR ENERGY. Wirtz, K. (Kernforschungszentrum, Karlsruhe, Ger.). Brennst.-Waerme-Kraft, 20: 245-50(June 1968). (In German).

After the successful evolution of the second reactor generation important problems of a technical, economic, and political nature determine the further development. They result from the requirement for complete reliability and safety of reactor operation and

the supply of fissile material. The development of the third generation of reactors, the fast breeders and high temperature reactors, permits the elaboration of strategies for the nuclear energy programmes which ensure the meaningful interplay of the different reactor types with respect to the supply of fissile material, fuel fabrication, and fuel reprocessing. This also raises the problem of a European plant for the enrichment of fissile material. (auth)

39823 TECHNICAL CHARACTERISTICS OF THE NIEDERAICHBACH NUCLEAR POWER PLANT. Preuss, H.-J. (Siemens AG, Erlangen, Ger.). Brennst.-Waerme-Kraft, 20: 251-7(June 1968). (In German).

The Niederaichbach prototype power plant will be equipped with a heavy-water moderated, CO_2-cooled pressure tube reactor for an electric net output of 100 MW. The principle underlying this novel reactor type and the lay-out of the power station are described. Some particular technical problems of this pressure tube reactor, such as selection of materials, design of the fuel elements, the coolant channels, and the moderator-tank are discussed. Possible developments are expected in an integrated system and in combination with a CO_2-gas turbine. (auth)

39824 BASIS AND DESIGN OF THE FIRST NUCLEAR POWER PLANT WITH DIRECT CYCLE GAS TURBINE (GEESTHACHT). Keller, C. (Forschungs- und Entwicklungsabteilung, Zurich). Brennst.-Waerme-Kraft, 20: 257-9(June 1968). (In German).

After summarizing the characteristics of helium as working medium for closed cycle gas turbines the layout of the Geesthacht 25 MW(e) nuclear plant is shown. This plant presents a prototype installation for future big units with a high temperature reactor directly coupled with a helium-gas turbine. (auth)

39825 DEVELOPMENT OF VALVES FOR THE MAIN CIRCUITS OF NUCLEAR POWER STATIONS. Kreuz, A. (Technische Abteilung, Moenchengladbach, Ger.). Brennst.-Waerme-Kraft, 20: 260-5(June 1968). (In German).

Valves for nuclear power stations require a very high degree of tightness, short controllable actuation times, special attention being paid to the quality control of materials and machining of components used in manufacture and the assembly of valves under clean conditions. Improvement in design was achieved in the first instance for the sealing tolerance and for the actuation of important functional elements. Quick opening and quick closing valves controlled by the working fluid especially have proved particularly reliable. The possibility of reducing the necessary documentation and materials certificate for nuclear power plant valves by manufacturing inspections and permanent tests are discussed. Large valves are tested under conditions similar to the actual working conditions in which they are to be installed completely before their final acceptance test. (auth)

39826 TECHNICAL DEVELOPMENT IN GERMANY OF SODIUM COOLED FAST BREEDER REACTORS. Brennst.-Waerme-Kraft, 20: 265-6(June 1968). (In German).

Design characteristics of a 300 MW(e) prototype Na-cooled fast breeder reactor concept are described. The reactor is fueled with a PuO_2-UO_2 mixture and has a UO_2 breeding blanket. The reactor primary circuit and building layout are illustrated. (H.D.R.)

39827 ADVANCED GAS COOLED REACTOR (AGR). Brennst.-Waerme-Kraft, 20: 266-7(June 1968). (In German).

Design characteristics of graphite-gas power reactors are described. The reactor structure and plant layout of a 600 MW(e) power station are illustrated, and the primary circuits of a 600 MW(e) plant and a 315 MW(e) plant are diagrammed. (H.D.R.)

39828 DATA SHEETS ON REACTOR CONTROL. Brennst.-Waerme-Kraft, 20: 267-73(June 1968). (In German).

Design and operating characteristics are tabulated for the VAK Reactor, MZFR, and AVR Reactor. Primary control circuits of each of the reactors are diagrammed. (H.D.R.)

39829 PROBLEM OF HYDRODYNAMIC STABILITY OF WATER COOLED REACTOR PRIMARY CIRCUITS. Buono, A.; Sangiovanni, G. (ENEL, Rome. Univ., Rome). Energ. Nucl. (Milan), 15: 433-40(July 1968). (In Italian).

The behavior of a water reactor cooling circuit is examined. Effects of oscillations in the coolant flow rate are analyzed for a particular temperature range during the heating phase of the primary circuit. Some phenomena observed during the start-up of the Garigliano nuclear power plant are described. An analog computer and a laboratory scale hydraulic circuit are used to evaluate observations. (M.L.S.)

39830 FUEL ELEMENT FOR A NUCLEAR REACTOR. Mogard, Johan Hilding (to Aktiebolaget Atomenergi). U. S. Patent 3,386,887. June 4, 1968. Priority date July 24, 1964, Sweden.

A nuclear reactor fuel element of the combined boiler-superheater type comprises a fissile fuel body having spaced recessed portions on its surface and a cladding over the fuel body which contacts those portions of the body surface which are not recessed. The resulting recesses are either gas-filled or vacated so as to constitute a heat insulation. A desired control of the heat flux is effected by varying the width or depth of the recesses in one zone of the fuel body with respect to the recesses in a second spaced zone. The zones are axially disposed along the fuel element, whereby, for example, the heat flux on the steam side of the element may be graduated in its intensity from one zone to another in series. (Offic. Gaz.)

39831 NUCLEAR REACTOR REACTIVITY CONTROL BY BUBBLING GAS THROUGH MODERATOR LIQUID. Whittier, Angus Charles (to Canadian General Electric Co. Ltd.). U. S. Patent 3,386,886. June 4, 1968. Filed Aug. 26, 1966.

To vary the effective neutron capture cross section of the moderating liquid in a heavy water moderated reactor, helium gas is bubbled through the moderator at a controlled rate. The level of moderator is maintained constant in the reactor to avoid diminution of the bubbling effect. (Offic. Gaz.)

39832 THREE NATIONS DEVELOPING HEAVY-WATER NUCLEAR UNITS. Baer, F. H. (McGraw-Hill World News, Vienna). Elect. World, 168: 36-8(Nov. 20, 1967).

The development programs for advanced breeder reactor systems in France, West Germany, and Czechoslovakia are described. The reactor programs consist of heavy water-moderated CO_2-cooled reactors. Design parameters for the A-1, KKN, and EL-4 reactors are presented. (D.C.C.)

39833 FUEL ASSEMBLY FOR FAST NUCLEAR REACTORS. Costes, Didier (to Commissariat a l'Energie Atomique). U. S. Patent 3,378,452. Apr. 16, 1968. Priority date Oct. 8, 1965, France.

A fuel assembly for a fast reactor has the lowest fuel rod cluster suspended from the cluster located above it. The clusters are mounted in a sleeve having a bottom opening large enough for the lowest cluster to fall freely upon failure of the suspension cluster. (Offic. Gaz.)

39834 CERMET AND CERAMIC FUEL ELEMENT. Davidson, John K.; Miller, Richard S. (to Allis-Chalmers Mfg. Co.). U. S. Patent 3,378,457. Apr. 16, 1968. Filed Aug. 18, 1965.

A fuel element for a fast reactor is described. The fuel element is a combination of the tubular-shaped cermet fuel member forming a cylindrical chamber; a metallic sheath surrounding the outer surface of the cermet cylinder; multiple metallic disks spaced inside the cermet cylinder to form small chambers; and a small ceramic fuel pellet inside each chamber of the cermet cylinder. (Offic. Gaz.)

39835 CONVERTER FUEL ELEMENT FOR NUCLEAR REACTORS AND METHOD OF PRODUCING THE SAME. Janner, Karl; Olbrich, Otto (to Siemens Aktiengesellschaft). U. S. Patent 3,387,148. June 4, 1968. Priority date Nov. 26, 1964, Germany.

A converter fuel element for a nuclear reactor includes a plurality of serially connected thermionic diodes, each having an annular emitter electrode and nuclear fuel for the reactor carried by the electrode. The electrode defines a hollow space surrounding the nuclear fuel and having a volume greater than any expanded volume of the nuclear reactor resulting from burn-up of the nuclear fuel in the reactor. Stresses produced by the volume increase of the fuel are absorbable in the space for maintaining the dimensional stability of the peripheral surface of the annular emitter electrode. A wave-shaped metal foil or metallic wool can be received in the space. (Offic. Gaz.)

39836 GAS TURBINE PLANT FOR UTILIZING THE HEAT PRODUCED IN A NUCLEAR REACTOR. (to Escher Wyss Aktiengesellschaft). British Patent 1,120,614. July 24, 1968. Priority date Oct. 7, 1964, Switzerland.

A description of a closed circuit gas-turbine power plant is presented. The turbine stage is driven by working medium directly from the reactor core and also from a heat exchanger. The reactor and heat exchanger are arranged on opposite sides of the turbine flow circuit. An auxiliary turbine serves as a jet pump drive to maintain fluid flow in the core and heat exchanger system. (D.C.C.)

39837 NUCLEAR ENERGY IN SOUTH AFRICA. Roux, A. J. A. S. Afr. Mech., Eng., 68-80(Sept. 1967).

Evaluation of South Africa's contributions to the world-wide

nuclear power industry is presented. Present uranium deposits, ore processing facilities, and fuel and fuel element fabrication capabilities are analyzed. Reactor development in South Africa is described. The production and applications of radioisotopes are also described. (D.C.C.)

39838 CONVERTER FUEL ELEMENT FOR A NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,121,333. July 24, 1968. Priority date Nov. 25, 1964, Germany.

A converter fuel element for a nuclear reactor is described. The fuel element includes multiple thermionic converter diodes arranged with emitter and collector electrodes extending around a common axis. The electrodes move in a manner to increase or decrease the spacing between them. The center of the emitter electrodes consists of high temperature-resistant ceramic material. A flat or conical assembly of laminated springs serves to position the electrodes and connect them electrically. The axial displacing device for the electrodes consists of an electrically-heated elongated thermal expansion member. (D.C.C.)

39839 NUCLEAR REACTOR PLANT. (to Sulzer Brothers Ltd.). British Patent 1,121,430. July 24, 1968. Priority date July 14, 1966, Switzerland.

A description of a gas-cooled nuclear reactor is presented. The reactor consists of a vertically suspended core penetrated by multiple fuel and control tubes. The tubes penetrate a horizontal intermediate floor and allow gas coolant entrance. The intermediate floor is suspended from the pressure vessel. A heat exchanger is located beneath the reactor core. (D.C.C.)

39840 REACTOR SAFETY DEVICE. Olsson, Curt Sigvard (to Aktiebolaget Atomenergi). British Patent 1,119,858. July 17, 1968. Priority date Oct. 15, 1964, Sweden.

A shutdown system for a water-cooled nuclear reactor is described. The system consists of a neutron-absorbing rod supported vertically over the reactor core. The rod is contained in a cylinder which provides a water pressure support system for the rod. When the water pressure is lowered the rod is gravity driven into the core. An annular flange prevents the rod from passing out of the cylinder in its lowered position. A cable device services the rod system to reset the rod in an upper position after being actuated. (D.C.C.)

39841 NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,119,990. July 17, 1968. Priority date Jan. 14, 1965, United States.

A description of a fused-salt-fueled, liquid lead-cooled nuclear reactor is presented. The reactor consists of a containment vessel with a reservoir of liquid lead in the bottom. The core floats on this reservoir and cooling liquid lead flows downward through the core into the reservoir. The core is surrounded by a blanket region that is also cooled by liquid lead. (D.C.C.)

39842 IMPROVEMENTS IN OR RELATING TO AN INTEGRAL VAPOUR GENERATOR-NUCLEAR REACTOR. (to Babcock and Wilcox Co.). British Patent 1,120,040. July 17, 1968. Priority date May 24, 1966, United States.

A description of a pressurized-water nuclear reactor is presented. The reactor consists of a cylindrical pressure vessel and an annular secondary pressure vessel enclosing the lower portion of the first pressure vessel. The heat transfer system functions as an integral vapor-generating system. The primary coolant flows through U-shaped tubes in the secondary pressure vessel. The secondary coolant flows over the U-shaped tubes. (D.C.C.)

39843 METHOD AND APPARATUS FOR GENERATING POWER BY NUCLEAR FISSION IN A HIGH TEMPERATURE REACTOR. (to Waagner-Biro Aktiengesellschaft). British Patent 1,120,078. July 17, 1968. Priority date June 27, 1966, Austria.

A description of a gas-cooled power reactor is presented. The reactor generates electric power by combining a thermionic or thermoelectric process with a magnetogasdynamic process. (D.C.C.)

39844 NUCLEAR REACTOR WITH AN INTEGRAL CHARGE DEVICE AND HEAT EXCHANGER. Arathoon, Jean-Paul; Gillieron, Claude; Leroy, Claude; Peuchmaur, Alphonse (to Commissariat a l'Energie Atomique). British Patent 1,120,930. July 24, 1968. Priority date Aug. 5, 1966, France.

A description of a nuclear reactor with a prestressed concrete pressure vessel is presented. The biological shielding of the reactor consists of two hollow, cylindrical, prestressed concrete units. The units are lined with a sealing skin and joined to form an inverted T. The horizontal lower unit contains the reactor core with fuel access openings. The vertical upper unit contains the heat exchanger. The reactor is gas-cooled and liquid-moderated. (D.C.C.)

39845 NUCLEAR REACTOR PLANTS. Kaegi, Jakob (to Sulzer Brothers Ltd.). British Patent 1,120,345. July 17, 1968. Priority date Feb. 23, 1966, Switzerland.

A description of a gas-cooled reactor cooling system is presented. The reactor consists of a pressure vessel with multiple inlet and outlet cooling ducts. The ducts form coolant flow circumferentially to the reactor axis. The ducts contain steam generator heat exchangers. Circulating blowers are connected to the axial discharge ducts. (D.C.C.)

Marine and Portable Power Reactors

39846 SAFETY PROBLEM IN NUCLEAR SHIPS, IN RELATION TO THE MAXIMUM CREDIBLE ACCIDENT. Argiero, Luigi (Univ., Pisa, Italy). Tec. Ital., 32: 357-66(June 1967). (In Italian).

After a brief review of general safety problems in nuclear ships, the factors which influence the maximum credible accident are examined. These factors are: power being developed at the time; release of radioactive fission products and their leakage from the containment; ventilation and air filtration of the machinery spaces; atmospheric dilution; and method of calculating dosage. These factors are considered in relation to an accident to a 100-MW(t) PWR which uses slightly enriched uranium. Detailed results of this examination are presented and discussed in relation to health hazards, and some conclusions are drawn. (auth)

39847 NUCLEAR SHIP "OTTO HAHN". Atomwirt., Atomtech., 13: 294-330(June 1968). (In German).

Design, construction, and performance aspects of the Otto Hahn and its advanced pressurized water reactor propulsion unit are discussed. The Otto Hahn is a research ship intended to provide experience in the operation of nuclear merchant ships, to evaluate the performance and reliability of the nuclear propulsion unit, and to permit the training of operating personnel for future nuclear ships. The reactor generates a thermal power of 38 MW, which corresponds to a drive power of 11,000 shp. The reactor is fueled with 4.03% enriched UO_2 in stainless steel cans. A single pressure vessel encloses the core, a steam generator, primary circulatory pumps, and pressure containment, and the pressure vessel is enclosed in a safety containment which is gas tight and can withstand the maximum possible overpressure arising from an accident. Separate sections discuss: prospects for nuclear propulsion in merchant shipping, special aspects of the Otto Hahn ship construction, reactor plant design, construction aspects of the reactor, zero power tests, commissioning tests, description of the fuel elements, European collaboration efforts in the project, the physical research program, development program for the second core, future development of the reactor, legal aspects of the Otto Hahn operation, and work at the Geesthacht Center on the project. Technical data tabulations, pictures, and a list of principal suppliers are included. (H.D.R.)

39848 ECONOMIC PROSPECTS FOR THE NUCLEAR PROPULSION OF MERCHANT SHIPS. Bianchi, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). Atomwirt., Atomtech., 13: 331-2(June 1968). (In German).

The principal factors influencing the economics of nuclear merchant ships are examined. Ship type, state of reactor technology, differences in cost structure for nuclear and conventional ships, and reduction of fuel bunker volume are discussed. It is concluded that tankers of 40,000 shp and containers ships of 30,000 shp show good prospects for economic nuclear propulsion. (H.D.R.)

Rocket and Space Reactors

39849 (LA-3449) ENVIRONMENTAL EFFECTS OF THE KIWI-TNT EFFLUENT: A REVIEW AND EVALUATION. Fultyn, R. V. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 68p. Dep. CFSTI.

The Kiwi Transient Nuclear Test (Kiwi-TNT) was a controlled excursion in which reactivity was inserted into a nuclear rocket engine prototype fast enough to vaporize a significant portion of the reactor core. The test studied the neutronic behavior of the reactor and the environmental effects of the radioactive materials released. The determination of environmental effects is described. The test was conducted at the Nuclear Rocket Development Station, Jackass Flats, Nevada, on January 12, 1965, at 1085 PST. The Los Alamos Scientific Laboratory collected en-

vironmental data from the test point to approximately 50 miles downwind. The U. S. Public Health Service monitored the neighborhood and collected milk samples in southern Nevada and California to beyond 200 miles downwind. The course of the effluent cloud was tracked by aircraft from the U. S. Public Health Service and EG&G. From 5 to 20% of the reactor core was vaporized, with approximately 67% of the products from about 3×10^{20} fissions released to the effluent cloud. Radiation effects from the cloud passage were less than predicted in the pretest safety evaluation report. The maximum off-site, integrated, whole-body exposure was 5.7 mRAD about 15 miles from the test point. No fresh fission products were detected in any of the milk samples. (auth)

39850 (N-68-12426) REACTOR CONCEPT FOR SPACE POWER EMPLOYING THERMIONIC DIODES AND PIPES. Heath, Colin A.; Lantz, Edward (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 15p. (NASA-TM-X-52370; CONF-670122-1). CFSTI.

From 5th Aerospace Science Meeting, New York.

A thermionic generator power system using a reactor heat source connected to external diodes by heat pipes is investigated. A concept capable of supplying up to several hundred kilowatts of electrical power is described. Experimental results from laboratory tests of both heat pipes and thermionic diodes have been used to set reasonable performance levels for thermionic diodes which are both heated and cooled by heat pipes. A reactor fueled with slab geometry fuel elements of uranium-233 nitride could provide a minimum power of 36 kW(e) limited by criticality considerations. Reactor control is effected by a combination of moderator and neutron absorbing material in a central region of the reactor. Neutronic calculations indicate that a 6% swing in reactivity is obtainable with this control system. Total mass of the reactor, thermionic diodes, radiator and reactor shield for an instrumented payload is estimated to be 300 kg. (auth) (STAR)

39851 (N-68-13501) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 1. SYNOPSIS OF METHODS AND RESULTS OF ANALYSIS. Final Progress Report. Capo, M. A.; Disney, R. K.; Jordan, T. M.; Woodsum, H. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1967. Contract NAS8-20414. 179p. (NASA-CR-91541; WANL-PR-(LL)-010(Vol.1)). CFSTI.

The three basic methods of calculating neutron and photon transport for nuclear rocket systems include: Monte Carlo, S_n transport, and point kernel. Evaluations of flexibility, convenience, accuracy, running time, and ability to obtain angular and energy distributions are described. Two nuclear rocket reactor geometrical models, an NRX-type and a flight-type reactor system, are analyzed using both the early and final design methods. Comparisons between NRX experimental gamma ray dose rates, fast neutron (E > 2.9 MeV) fluxes, and thermal neutron fluxes (E > 0.4 eV) and data calculated by both methods are presented. Also, the point kernel, S_n transport, and Monte Carlo methods are evaluated for the flight-type reactor system. This evaluation includes external environment and propellant heating in both an on-axis and an off-axis propellant tank. (auth) (STAR)

39852 (N-68-13502) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 2. THE POINT PROGRAM AND CROSS SECTION LIBRARY. Final Progress Report. Soltesy, R. G.; Disney, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1967. Contract NAS8-20414. 146p. (NASA-CR-91543; WANL-PR-(LL)-010(Vol.2)). CFSTI.

POINT (Preparation of Input for Transport), a FORTRAN IV program for the IBM 7094 computer, is described. This program contains the basic microscopic cross section library, and input data processing routines to prepare input for the one-dimensional TAPAT program system, the two-dimensional transport program ODD-K and the data processing code for ODD-K, NAGS. The calculation of macroscopic cross sections readily usable in the transport programs, TAPAT and ODD-K, is achieved by employing a built-in library of region independent neutron and gamma ray microscopic cross sections. These group-averaged cross sections are applicable for the analysis of graphite-moderated nuclear reactor rocket systems. The program also calculates response functions as punched card output for use in both the TAPAT and NAGS programs to calculate, for example, neutron and gamma ray energy deposition, fixed neutron sources, or prompt and secondary gamma ray sources. (auth) (STAR)

39853 (N-68-13503) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR THE NUCLEAR ROCKET SYSTEMS. VOLUME 3. TAPAT: THE FORTRAN 4 PROGRAM SYSTEM (THE ANALYSIS PROGRAM AND TRANSPORT). Final Progress Report. Disney, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1967. Contract NAS8-20414. 113p. (NASA-CR-91542; WANL-PR-(LL)-010(Vol.3)). CFSTI.

A description of the TAPAT program system is presented which consists of five FORTRAN IV subprograms: the ADDICT diffusion theory program which solves the multigroup diffusion equations in one-dimensional slab, cylindrical, or spherical geometries; the MIST transport theory program which solves the multigroup S_n transport equations in one dimensional slab geometry; the TOPIC transport theory program which solves the multigroup S_n transport equations in one-dimensional cylindrical geometry; the MISPHT transport theory program which solves the multigroup S_n transport in one-dimensional spherical geometry; and the FLUX EDIT data processing program which calculates reaction rates, distributed fixed sources, separable spatial and energy source distributions, and other radiation quantities of interest. The TAPAT subprograms ADDICT, MIST, MISPHT, and TOPIC are modifications of previously coded diffusion and S_n transport programs. The input data and internal operations of each program are standardized in a single program system that provides a complete, neutron and photon, one-dimensional radiation analysis of a reactor system in a single computer run. (auth) (STAR)

39854 (N-68-13504) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 4. KAP-V: THE POINT KERNEL ATTENUATION PROGRAM. Final Progress Report. Disney, R. K.; Capo, M. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1967. Contract NAS8-20414. 184p. (NASA-CR-91540; WANL-PR-(LL)-010(Vol.4)). CFSTI.

A description of the neutron and gamma ray point kernel attenuation program KAP-V, a computer program written in FORTRAN IV language, is presented. The program employs the point kernel method to calculate radiation levels at detector points located within or outside a complex radiation source geometry describable by a combination of quadratic surfaces. This program can be used, for example, to calculate gamma ray and/or fast neutron flux, dose, or heating rate. The attenuation function, or kernel, for gamma rays employs exponential attenuation along with a build-up factor. Three optional fast neutron attenuation functions are included: a modified Albert–Welton function for calculating fast neutron dose rate using removal cross sections; a bivariant polynomial expression for computing neutron spectra using infinite media moments data; and a monovariant polynomial expression for computing neutron spectra using infinite media moments data. The program also handles either cylindrical, spherical, disc, line, or point sources. A variety of options are available for describing neutron or gamma ray source distributions in complex geometries. (auth) (STAR)

39855 (N-68-13505) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 5. TIC-TOC-TOE: A FORTRAN PROGRAM FOR THE TEMPERATURE IN THE COOLANT TANK AND OTHER CALCULATIONS AND FOR THE THERMAL NEUTRON ORIGINATING ENERGY. Final Progress Report. Jordan, T. M.; Woodsum, H. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1968]. Contract NAS8-20414. 56p. (NASA-CR-91533; WANL-PR-(LL)-010(Vol.5)). CFSTI.

A description of the TIC-TOC-TOE program for the Temperature in the Coolant Tank and Other Calculations and for the Thermal neutron Originating Energy is given. The TIC-TOC-TOE program written in FORTRAN IV language, performs rapid calculations of heating rate distributions in on-axis liquid hydrogen propellant tanks. Neutron and photon sources from the reactor are expressed as multigroup, angular equivalent point sources. The propellant tank geometry is described by a series of axisymmetric truncated cones and/or cylinders. Basic heating rate data are interpolated from curve-fits of M. O. Burrell's Monte Carlo data which are built into the program. (auth) (STAR)

39856 (N-68-13506) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 6. ODD-K: A TWO-DIMENSIONAL TRANSPORT CODE. Final Progress Report. Disney, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1967]. Contract NAS8-20414. 81p. (NASA-CR-91534; WANL-PR-(LL)-010 (Vol.6)). CFSTI.

The manual for the utilization of the ODD-K program which numerically solves the Boltzmann transport equation using a

multigroup, discrete direction representation of the particle flux in a two-dimension (R-Z, R-θ, or X-Y) geometry description of a reactor is presented. The ODD-K program provides, in conjunction with the NAGS and DAFT codes, a method for obtaining neutron and photon spatial and energy distributions throughout the reactor system, and spatial, energy, and angular distributions of leakage fluxes at the surface of the reactor system. The code is presently operational on an IBM 7094 computer under the independent FORTRAN II monitor system. Tape assignments are compatible with the Marshall Space Flight Center (MSFC) IBM 7094 computer system. In addition, the ODD-K program operates under a revised FLOCO assembly program, FLOCOW II, which operates as a FORTRAN II monitor system program with off-line input, off-line output and FORTRAN II or IV tape operations. (auth) (STAR)

39857 (N-68-13507) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 7. NAGS: A FORTRAN 4 DATA PROCESSING PROGRAM FOR CALCULATION OF NEUTRON AND GAMMA-RAY SOURCES AND NEUTRON AND GAMMA RAY HEATING IN TWO DIMENSIONAL GEOMETRIES. Final Progress Report. Disney, R. K.; Soltesz, R. G.; Zeigler, S. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1967]. Contract NAS8-20414. 103p. (NASA-CR-91535; WANL-PR-(LL)-010(Vol.7)). CFSTI.

A description of the Neutron Flux and Gamma Ray Source Edit (NAGS) program is presented. The NAGS program is a series of FORTRAN IV routines which process multigroup neutron and photon energy fluxes for two dimensional (R,Z or R,θ) geometry models. The NAGS program provides: neutron and photon energy sources and distributions for use in point kernel, Monte Carlo, and photon transport analyses; neutron and gamma ray dose rates; and energy deposition data for use in subsequent thermal analyses. Source distributions which are output from the NAGS program are employed as input to the KAP-V point kernel program, the ODD-K two dimensional transport program, and the FASTER Monte Carlo program. (auth) (STAR)

39858 (N-68-13508) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 8. DAFT: ODD-K ANGULAR FLUX TAPES PROGRAM. Final Progress Report. Disney, R. K.; Zeigler, S. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1967]. Contract NAS8-20414. 47p. (NASA-CR-91536; WANL-PR-(LL)-010(Vol.8)). CFSTI.

A description of the DAFT (ODD-K Angular Flux Tape) program (a FORTRAN IV program for the IBM 7094 computer) is presented. This program is the data processing routine which prepares angular, spatial, and energy distribution data for input to the FASTER Monte Carlo program from the surface angular leakage flux data of the two-dimensional transport program ODD-K. The processing of the surface flux data in a form readily usable in the Monte Carlo program is achieved by reducing the surface multigroup angular leakage flux data into a histogram representation of the spatial, angular, and energy flux at the surface of a two-dimensional (R,Z) cylindrical reactor mockup. The DAFT program reduces the ODD-K surface angular flux data such that a limited number of areas, each having a defined angular energy flux, at the periphery of a reactor can be input to the FASTER program. Subsequently, the FASTER program can be used to predict the external radiation environment and/or propellant tank heating with a minimum amount of computer time and a maximum of accuracy for a given cost. If this ODD-K, DAFT combination is not used, the FASTER program must be used with volume distributed sources. (auth) (STAR)

39859 (N-68-13509) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME 9. FASTER: A FORTRAN ANALYTICAL SOLUTION OF THE TRANSPORT EQUATION BY RANDOM SAMPLING. Final Progress Report. Jordan, T. M. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1967. Contract NAS8-20414. 265p. (NASA-CR-91538; WANL-PR-(LL)-010 (Vol.9)). CFSTI.

A description of the FASTER program, a Fortran Analytic Solution of the Transport Equation by Random sampling, is presented. FASTER is a Fortran IV Monte Carlo program which calculates energy dependent neutron or photon fluxes at points, surfaces and regions of complex geometries. This program contains all the data processing routines required for a wide variety of nuclear vehicle applications. The FASTER program is completely variable dimensioned, and hence, is capable of treating problems of varying complexity within the limitation of total computer storage. The FASTER program deals with the entire spectrum of particle energies simultaneously, thus eliminating costly repetition of geometric calculations which are usually required for treating individual monoenergetic particles. The scattered particle energy spectra include the effect of every possible scattering event at each scattering point. This eliminates the variance associated with the random selection of a single event. Neutron transport calculations utilize averaged multigroup cross sections which are available from several standard tabulations. Photon transport problems utilize point cross sections and the Klein-Nishina equation for Compton scattering. (auth) (STAR)

39860 (N-68-18197) PRELIMINARY CONSIDERATIONS FOR FAST-SPECTRUM, LIQUID-METAL COOLED NUCLEAR REACTOR PROGRAM FOR SPACE-POWER APPLICATIONS. Lahti, Gerald P.; Lantz, Edward; Miller, John V. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 49p. (NASA-TN-D-4315). CFSTI.

A preliminary study was made in which reactor size and shield weight requirements were calculated for several compositions of uranium nitride and uranium dioxide fuel materials under various operating conditions. A fast-spectrum, lithium-cooled reactor was selected for the study since it potentially will result in the smallest reactor that is capable of operating at the required temperature levels. In order to determine man-rated shielding requirements, a 2-millirem-per-hour radiation dose at 66 feet was selected as a reasonable value, being of the same order of magnitude as that which would be received from galactic cosmic rays in interplanetary space. Nuclear criticality and the allowable fuel burnup limits essentially determine the required reactor size and resulting weight of the shielding. The importance of the other variables, such as allowable steady-state heat-transfer limits, coolant temperatures, flow rates, and coolant hole sizes, is only secondary in determining the weight of the reactor plus shield. Choice of the proper value for each of these parameters can be based on overall system performance, availability of design data, material limitations, and manufacturing feasibility. (auth) (STAR)

39861 (N-68-18243) CONTAINMENT EXPERIMENTS IN VORTEX TUBES WITH RADIAL OUTFLOW AND LARGE SUPERIMPOSED AXIAL FLOWS. Kendall, John S.; Mensing, Arthur E.; Johnson, Bruce V. (United Aircraft Corp., East Hartford, Conn.). Mar. 1968. Contract NASw-847. 92p. (NASA-CR-993; F-910091-12). CFSTI.

An experimental investigation is conducted to determine the heavy-gas containment characteristics of radial-outflow vortexes for potential application to a vortex-stabilized open-cycle gaseous nuclear rocket engine. Tests are conducted in a constant-temperature vortex with Reynolds numbers based on the superimposed axial flow up to those expected in a full-scale engine. Air is employed to simulate the seeded hydrogen propellant and a heavy fluorocarbon is used in most tests to simulate the gaseous nuclear fuel. The effects on heavy-gas containment of changes in the vortex tube length-to-diameter ratio, the light-gas injection geometry and area, the ratio of average heavy-gas density to light-gas density, and the density of the heavy gas at injection are studied. The containment parameters vary significantly only with vortex tube length-to-diameter ratio and the ratio of average heavy-gas density to light-gas density. The results of some tests using helium injected near the centerline of the vortex indicate that the presence of a light gas in the central region of the vortex has a significant favorable effect on containment characteristics. (auth) (STAR)

39862 (N-68-18252) FEASIBILITY STUDY OF A TUNGSTEN WATER-MODERATED NUCLEAR ROCKET. 7. SYSTEM DYNAMICS AND CONTROL ANALYSIS. Mihaloew, James R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 98p. (NASA-TM-X-1426). CFSTI.

A system dynamics and control analysis was performed on several versions of a tungsten water-moderated (TWMR) nuclear rocket system, to determine its overall feasibility and control requirements from chilldown to startup and power range operation. Results of steady-state mapping of the TWMR showed that heat exchanger hydrogen bypass was required to prevent icing in the water-moderator cooling heat exchanger. A comparative system analysis of the several TWMR versions showed that the all-topping cycle version with heat exchanger bypass was substantially superior with respect to system simplicity and flexibility at the design chamber pressure of 600 psia. However, a split-feed cycle version with heat exchanger bypass represented the most promising system because of its superior chamber pressure uprating potential. The control analysis of this version showed that chamber temperature control with a poison insertion-extraction scheme was extremely fast in response, but necessarily discontinuous. Chamber temperature control with heat exchanger bypass was comparatively slow but inherently continuous. A control system

based on heat exchanger bypass for primary chamber temperature control and poison reactivity for augmentation was demonstrated satisfactorily over a typical operating cycle. (auth) (STAR)

39863 (N-68-18460) SNAP-8 SIMULATOR LOOP MECHANICAL DESIGN. Valerino, Alfred S.; Wood, James C.; Reznik, Joseph F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 65p. (NASA-TM-X-1515). CFSTI.

A SNAP-8 system simulation facility was designed, assembled, and tested. Design flow rates of the three-loop system were 32,000 lb/hr of eutectic NaK in both the primary and heat-rejection loops and 9100 lb/hr of Hg in the power loop. The turbine, radiator, and nuclear reactor were simulated. A prototype boiler and condenser were employed. Fluid circulation was obtained by electromagnetic pumps and a centrifugal pump for NaK and Hg, respectively. Test results indicated errors in Hg vapor flow rate due to erosion and/or corrosion of the entrance and throat sections of choked venturis. The location of spark-plug-type liquid-level indicators in the expansion tanks of the NaK loops resulted in frequent shorting of the indicators. Gas and vacuum lines located atop the tanks were often plugged. Metal flexible hoses installed to alleviate thermal expansion of the piping by lateral movement of the hoses were safely employed in the liquid metal loops. The NaK electric heater employed as the heat source in the primary loop was replaced because of external leaks and electric shorting of the heater-element lead wires. (auth) (STAR)

39864 (N-68-19001) INSTRUMENTATION OF A SNAP-8 SIMULATOR FACILITY. Deyo, James N.; Wintucky, William T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 61p. (NASA-TM-X-1525). CFSTI.

The performance of high temperature instrumentation, pressure sensors, thermocouples, and flowmeters is discussed. Secondary and support instrumentation in the test facility and control room are also included. The approach described is based on the parameters to be measured as well as the time schedule, physical characteristics, and available instrumentation for the facility. Results include data handling, accuracy, and reliability of the system. Over 2000 hours of operation were accumulated, during which time the mercury loop was at operating temperature for about 1000 hours. More than 2000 data runs were taken. (auth) (STAR)

39865 (N-68-19830) EXPLORING IN AEROSPACE ROCKETRY. 19. NUCLEAR ROCKETS. Lietzke, A. F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1968. 16p. (NASA-TM-X-52406). CFSTI.

The functions, limitations, and expected performance of a nuclear rocket are described; and the difference between nuclear and chemical rockets is illustrated. Based on the interactions between neutrons and atomic nuclei, the operating principles of the nuclear rocket are delineated. The fission processes of uranium and plutonium are presented, and it is shown that by controlling the neutron population, the desired power may be obtained. An assessment is made of two thermal reactors and one a fast reactor, and the various functions and components of each are summarized. Diagrams are drawn to illustrate concepts discussed. (STAR)

39866 (N-68-21111) POSTSHUTDOWN COOLING REQUIREMENTS OF TUNGSTEN WATER-MODERATED NUCLEAR ROCKET. Paulson, Walter A.; Crawford, Ray M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 23p. (NASA-TM-X-1568). CFSTI.

The postshutdown cooling requirements are calculated for the tungsten water-moderated reactor concept. The reactor is assumed to have operated at full power for 1 hour. An amount equivalent to 5.25 percent of the hydrogen used during the operation at full power is required to remove the energy generated after shutdown. The postshutdown cooling schedule requires continuous hydrogen flow for the first 1000 seconds followed by 23 pulsed cooling periods. The last hydrogen pulse occurs at 6.1 days after shutdown. The pulse flow rate is 0.3 pound per second (0.136 kg/sec) and the duration of the pulses range from 4250 seconds early in the schedule to 1300 seconds at later times. (auth) (STAR)

39867 (N-68-21402) NERVA PROGRAM STATUS. Schroeder, Robert W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 10, 1968. 25p. (NASA-TM-X-60977; CONF-680436-1). CFSTI.

From 5th Symposium on Advanced Propulsion Concepts, Chicago, Ill.

Activities are described for the NERVA program, which presently encompasses both technology and engine programs. Reactor design and development is discussed; as are the interactions among reactor, nozzle, turbopump, and control system during integrated testing. Attention is also given to basic and safety factors. Fabrication efforts are also involved, including the means to mass produce fuel elements with consistent characteristics at reasonable costs and with reasonable yield ratios. Major efforts have also been applied toward producing regeneratively-cooled nozzles with large numbers of thin-walled coolant tubes that have reproducible characteristics and are consistently sound bonding. A section on reactor development is devoted to full scale reactor testing of graphite reactors. Chamber temperatures of more than 4000°C have been demonstrated. (STAR)

39868 MODEL INVESTIGATION OF THE NECESSARY EXPENDITURES FOR FAST INTERPLANETARY FLIGHT BY USE OF IMPROVED NUCLEAR MOTORS AND FUEL SUPPLIES AT THE TARGET. Marx, Guenter (Technical Univ., Berlin). VDI. (Ver. Deut. Ing.) Z., 110: 707(June 1968). (In German).

A mathematical model of the expenses required for short-time interplanetary missions using advanced nuclear engines and refueling at the target planet is described. (auth)

39869 OPTIMIZATION METHOD OF REACTOR SIZING WHICH ACCOUNTS FOR SYSTEM AND TECHNOLOGICAL CONSTRAINTS. Longo, J. Jr. (General Eelctric Co., Cincinnati). Nucl. Eng. Design, 7: 470-80(May 1968).

A method is described which permits the nuclear engineer to determine: the value of the pertinent reactor dimensions which provide the desired objective (optimization function) to be met within technological and system input constraints; the limiting technological and system input constraints; and quantitative measures of the benefits to be accrued by development work and/or changes in system inputs. The method has been applied to a fast spectrum, reflector controlled, liquid metal cooled, cermet fuel space power reactor to illustrate its potential. (auth)

39870 SPACE HEAT REACTOR. Stathoplos, Anthony (to United Nuclear Corp.). U. S. Patent 3,377,207. Apr. 9, 1968. Filed Oct. 19, 1965.

A water-cooled and moderated non-boiling low pressure nuclear reactor is used for space heating purpose and for providing electrical power. The reactor is self regulating at equilibrium power level without internal moving mechanical elements such as conventional control rods. Within the pressure vessel of the reactor a shroud is used to divide the inside of the vessel into an inner and an outer zone for housing the reactor core and heat exchanger respectively. The water coolant is circulated among the inner and outer zones by natural convection. A depleted uranium blanket surrounding the periphery of the pressure vessel is provided to capture neutrons escaped from the reactor core. The blanket is used as hot junctions and the outside of the pressure vessel as cold junctions for thermal electrical elements to generate electricity. (Offic. Gaz.)

Process Heat and Desalination Reactors

Refer also to abstract 39738.

39871 CHARACTERISTICS OF DUAL-PURPOSE DESALINATION AND ELECTRIC PLANTS USING THE SAME HEAT SOURCE. D'Orival, M. (Commissariat a l'Energie Atomique, Saclay, France). Desalination, 4: No. 1, 66-79(1968). (In French).

Cheap energy in large quantity is one of the main factors permitting a decrease in desalted water cost. Dual-purpose plants show a good prospect in this connection, but, under certain conditions, the coupling of the two productions may be unfavorable. A thorough knowledge of the various concepts of dual-purpose installations provides guidelines either for selecting a plant design which suits a given situation, or for developing desalting processes in view of their use in dual-purpose plants. The main dual-purpose schemes are reviewed and their main features presented. The limits of application and operating problems are studied in the light of the thermodynamic and economic characteristics of the various types of installations. The various topics are examined for both conventional and nuclear installations. They are illustrated by means of examples from recent studies. (auth)

39872 INVESTIGATION OF THE PRACTICABILITY OF A REACTOR INSTALLATION FOR SEA WATER DESALINATION. Kostikow, L. E.; Montschinski, A. G.; Tokarew, J. I.; Mironow, W. I. (Staatskomitee fuer Atomenergie-Ausnutzung, Moscow). Desalination, 4: No. 1, 103-18(1968). (In German).

The applicability of various types of reactors to desalination of sea water is considered. Design data are included for: organic cooled reactors and graphite moderated pressure tube reactors.

Design data for the turbine units are tabulated. Both dual- and single-purpose desalination reactor installations are considered. An economic analysis is included. (M.L.S.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 37970 and 39003.

39873 (AAEC/TM–433) PRELIMINARY SURVEY OF REQUIREMENTS FOR HEAVY WATER MODERATED REACTOR LATTICE EXPERIMENTS IN THE PROPOSED CRITICAL FACILITY. Dalton, A. W.; McCulloch, D. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1968. 20p. Dep.

Calculations to assess the fuel and control requirements for lattice measurements in heavy water moderated reactor cells, using a "splittable" type machine with a ^{235}U/graphite driver region, are presented. The METHUSELAH code is used to calculate cell-averaged cross-section data for the heavy-water moderated region, and GYMEA for the ^{235}U/graphite driver region and the graphite reflector. CRAM calculations in four groups are made for critical configurations in a range of driver region compositions and assembly geometries. For the type of natural uranium steam-generating heavy water reactor lattice considered, an adequately close approximation to the equilibrium neutron spectrum for the critical SGHWR can be established over a 30 cm radius at the centre of the assembly, using approximately one ton of SGHWR type fuel, 9 kg ^{235}U and 13 tons of graphite. The latter two quantities can be somewhat increased if practical packing densities for the machine are taken into account. Adequate reactivity control for operation is available by use of a practicably small number (about 5) of conveniently sized plates "black" to thermal neutrons. (auth)

39874 (ANL-Trans–616) CONSIDERATIONS ON THE OPTIMUM LAYOUT OF THE EXPERIMENTAL FACILITIES FOR THE SORA-PULSE REACTOR. Kley, W.; Haas, R.; Misenta, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Italian report. 19p. Dep. CFSTI.

A description of the SORA pulse reactor is given; beam tube layouts are shown. Design considerations for neutron beam experiments in SORA are outlined; these include brief descriptions of the various spectrometers, neutron diffraction techniques using powdered samples, and coherent inelastic scattering techniques. (M.L.S.)

39875 (BNL–50082, pp 1-18) REACTOR PHYSICS DIVISION. Chernick, J.; Kouts, H. (Brookhaven National Lab., Upton, N. Y.).

Developments are reported for studies on: reactor safety; Na temperature coefficient distribution in plenum reactors; fast reactor criticals; fast neutron transport; reactor dynamics; neutron thermalization; iteration methods; reactor kinetics; fluid dynamics; reactor physics HAMMER CODE; analysis of BNL ^{235}U–graphite critical experiments; analysis of Brookhaven $^{233}U-ThO_2$ lattices; spectrum-shift lattice experiments; small reflected assemblies; uranium–graphite critical assemblies; californium experiment; $^{233}UO_2-ThO_2-D_2O$ exponential experiments; anisotropy of neutron migration; physics of fast Na-cooled reactors; and support work for experiments. (D.C.C.)

39876 (CEA-R–3375) LA MESURE DE LA REACTIVITE DANS UN REACTEUR NUCLEAIRE. (Reactivity Measurements in a Nuclear Reactor). Amblard, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1968. 25p. (In French). Dep.

A mathematical model of a multifuel nuclear reactor is described. The principle of the continuous measurement of reactivity using the reactimeter is derived. As an example, the Pagels lattices associated with the reactimeter designed for Rapsodie are calculated. A reduction method for groups of delayed neutrons which govern the dynamic operation of the reactor is given. This problem has no rigorous solutions but with a relatively small error in reactivity measurement, the number of families can be reduced to three. (auth)

39877 (CEA-R–3393) ALIZE III: FIRST CRITICAL EXPERIMENT FOR THE FRANCO-GERMAN HIGH FLUX REACTOR. CALCULATIONS. Scharmer, Klaus (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 79p. Dep.

The results of experiments in the light water cooled D_2O reflected critical assembly ALIZE III are compared to calculations. A diffusion model is used with 3 fast and epithermal groups and two overlapping thermal groups; this leads to good agreement of calculated and measured power maps, even in the case of strong variations of the neutron spectrum in the core. The difference of calculated and measured k_{eff} was smaller than 0.5 per cent $\Delta k/k$. Calculations of void and structure material coefficients, reactivity of "black" rods in the reflector, spectrum variations, and delayed photoneutron fraction in the D_2O reflector are made. Measurements of the influence of beam tubes on reactivity and flux distribution in the reflector are interpreted with regard to an optimum beam tube arrangement for the Franco-German High Flux Reactor. (auth)

39878 (CEA-R–3406) LE DEMARRAGE DE RAPSODIE. (Start-Up of Rapsodie). Pontier, Robert (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Dec. 1967. 197p. (In French). Dep.

After giving a general description of RAPSODIE, the conditions in which the start-up occurred and in which the tests were carried out are described. A chronological account is given of the operations and of the main events which occurred. The modifications made to the reactor during this period are described and a synthesis of the results obtained is presented. (auth)

39879 (CEA-R–3416) MESURES NEUTRONIQUES DANS LE COEUR ET LES COUVERTURES DE RAPSODIE. (Neutron Measurements in the Core and Blankets of the Reactor Rapsodie). Gourdon, Jean; Edeline, Jean-Claude (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb. 1968. 101p. (In French). Dep.

Besides a brief general discussion, the core and blanket neutronic measurements are given. The methods, the measurements, and the results are described. The later concern: spectral indexes, axial and radial fission rates, activation foil measurements and neutronic power determination. (auth)

39880 (GEAP–5193) PLUTONIUM SUBCRITICAL EXPERIMENT PROGRAM. Eighth Quarterly Report, April 1–June 30, 1966. Carver, J. G. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). June 30, 1966. Contract AT(04-3)-189. 23p. (EURAEC–1715). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The Pressurized Subcritical System is fully operational. The fission plate will produce in the subcritical lattices adequate neutron fluxes for the Program measurements. Post-irradiation dose rates near the pressure vessel are low enough to permit reasonable access to the vessel. Excellent results have been obtained from the reciprocal-count-rate method of determining the multiplication of a subcritical lattice of constant diameter, through neutron counts obtained as poison is removed from the lattice. The method works particularly well for the volume-distributed source of neutrons from spontaneous fission of plutonium in the fuel. Indium and copper foil data from the first irradiation indicate that the neutron spectrum is essentially constant in the center zone of the lattice. High precision was evident in these measurements. When consistent cross section changes are introduced into the lattice analysis routine now in use, improved agreement with the EBWR critical experiments is accompanied by worse agreement with the PuAl criticals, and vice versa. (auth)

39881 (LA–3953) HIGH TEMPERATURE NEUTRON SOURCE FOR UHTREX. Wiesener, Robert W. (Los Alamos Scientific Lab., N. Mex.). June 5, 1968. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A $^{238}PuBe_{13}$ neutron source with an intensity of 1.3×10^7 n/sec has been fabricated and tested for use in the Ultra High Temperature Reactor Experiment (UHTREX). The source is doubly contained in niobium and is designed to operate in the reactor helium environment at 500 psi and 2400°F. It will be used to facilitate hot restart following a scram or shutdown from high temperature power operation. (auth)

39882 (ORNL-TM–2282) PRELIMINARY STUDY OF A MOLTEN-SALT BURST REACTOR. Perry, A. M.; Bauman, H. F.; McDonald, W. B.; Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). July 10, 1968. Contract W-7405-eng-26. 10p. Dep. CFSTI.

The possibility of using a molten-salt reactor to produce intense, sharp bursts of neutrons is described. Fluxes of 2.3×10^{16} neutrons/cm^2 per burst can be achieved in a central test cavity. This can be accomplished with a core perhaps 30 in. in outer diameter, having a volume of about 200 liters, and with a burst yield of about 700 MW sec. The neutrons are essentially all above 1 keV, and a third of the flux is above 100 keV. The estimated burst width is less than 1 msec. (auth)

39883 ACCIDENT ANALYSIS FOR A FAST SOURCE REACTOR. Mathis, A. (CNEN, Rome); Musso, B.; Turrini, E. Energ. Nucl. (Milan), 15: 450-60(July 1968).

The methods used for the accident analysis of the TAPIRO fast source reactor are described. The accidents considered are various kinds of reactivity insertions, leading possibly to meltdown of the core. The study has been based mainly on the use of analog computer models. (auth)

39884 EFFECT OF WATER GAPS ON THE PHYSICS OF LIGHT WATER REACTOR LATTICES. Haga, Tohru. Ithaca, N. Y., Cornell Univ., 1967. 135p.

Thesis.

The effect of central water gaps in a light water reactor on thermal neutron density distribution, thermal neutron importance, fast neutron importance, β_{eff}/A, and temperature coefficient of reactivity is extensively studied by experiment and theory. Water gaps with diameters up to 6.7 cm are introduced into the Cornell Zero Power Reactor core having a 1.5/1 water to UO_2 volume ratio. Thermal neutron densities are measured by dysprosium wire activation and compared with 45 thermal energy group, DS_4 spectrum calculations, and 4 group diffusion theory calculations, with good agreement. The thermal neutron density in the gaps shows strong variations in space and energy, and depend strongly on the gap size but weakly on the water temperature. Thermal neutron importance functions are determined using boron absorber reactivity measurements. The measured dips in the water gaps are compared with 4 group diffusion theory. Fast neutron importance functions are measured by the ^{252}Cf source introduction method. The small changes observed are predicted by the fast groups of the 4 group diffusion calculation. Values of β_{eff}/A are measured by pulsed neutron experiments at delayed critical and are compared with calculations using Henry's model for β_{eff} and A. Measured temperature coefficients of reactivity at 25°C change from −0.56¢/°C to −0.16¢/°C when the 6.7 cm water gap is introduced. Perturbation theory analysis agrees well with the experiments and provides a physical explanation for this complicated phenomenon. (Diss. Abstr.)

39885 STUDY OF CORE AND REFLECTOR TEMPERATURE PARAMETRIC EFFECTS ON THE CRITICALITY OF A HIGH-LEAKAGE THERMAL REACTOR. Ibe, Librado D. Lafayette, Ind., Purdue Univ., 1967. 117p.

Thesis.

A light-water moderated, graphite and light-water reflected open pool type reactor was studied for the variation of its effective multiplication factor with different core and reflector temperatures ranging from 0°C to 50°C. The main purpose of this investigation is to determine the range of core-reflector temperatures where positive temperature coefficients of reactivity could exist, which information will be of great value in the safety analysis of the reactor. The model on which the criticality calculations were based is the Purdue University Reactor PUR-1. This reactor has a core measuring 12 inches square by 24 inches high and is fueled with U–Al alloy plate type elements enriched in U-235 up to 93%. It is reflected by 3-inch thick graphite at the sides and light-water at the top and bottom. The pool water also serves as additional side reflector beyond the graphite regions. In the calculation procedure adopted, the core was first divided into small rectangular sections, called subcells, in a manner such that the fuel bearing portion of a fuel plate and its associated Al cladding and half-moderator on each side make up a fuel plate subcell, while the other subcells constitute only Al plates and water with different metal-to-water ratios. Each subcell was homogenized and element number densities computed for different selected temperatures. With the use of available digital computer codes and application of flux-weighting techniques, the subcell averaged fast and thermal group parameters were initially determined for each selected temperature and assumed reactor geometric bucklings. The equivalent homogenized core effective cross sections and diffusion coefficients were subsequently calculated by flux-weighting the subcell parameters over the core area. Two-group and four-group buckling search for criticality calculations was then performed on the reactor with the equivalent homogenized core, graphite and water reflectors, and with control rods out. A set of calculations was done for each combination of previously selected core and reflector temperatures and assumed geometric bucklings. That buckling giving the same calculated k_{eff} from the two-group and four-group approaches was taken as the proper geometric buckling and the k_{eff} determined in this manner was the reactor k_{eff} for the set of core and reflector temperatures considered. The reactor k_{eff} and geometric bucklings at other core-reflector temperature combinations were calculated in a similar manner. By making use of these results, curves for equal k_{eff}, called iso-k_{eff} curves, with core and reflector temperatures as co-ordinate axes, were generated. Positive coefficient of reactivity is predicted to arise as the reactor core and reflector temperatures are increased from 0°C to about 10°C. The iso-k_{eff} curves also indicate that the reflector temperature contributes to the reactor overall temperature coefficient although its effect is not as significant as that resulting from the core temperature. Another series of buckling and criticality searches were performed for a hypothetical core having the same height and composition as PUP-1 but with a square base measuring 18 inches on each side. The results show more gradual variations in the k_{eff} with core and reflector temperatures. (Diss. Abstr.)

39886 DETERMINATION OF REACTOR KINETIC PARAMETERS BY PHOTON OBSERVATION. Lehto, Wayne K.; Carpenter, John M. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 33: 225-37(1968).

Fission rate fluctuations at low power in a reactor with a large fission-product inventory have been observed in the pool-type Ford Nuclear Reactor. A gaseous Cherenkov detector was used to sense the high-energy, prompt-fission gamma rays in the presence of a fission-product gamma field of 10^5 to 10^6 R/h. The ratio β/l is determined from the cross power spectral density of the fluctuations in the signals from two of these detectors. Both this spectrum and the power spectral density of the output of a single detector show a large low-frequency component. This is attributed to moderator temperature fluctuations present when the fission-product decay heat is removed by natural circulation of the coolant. The temperature fluctuations as measured with a short-time-constant thermocouple are shown to be correlated to those in the fission rate. The detector is described, as well as a basis for calculating its performance and efficiency. A theory of the gamma noise experiment that reveals the effects of the detector on the measured spectrum is presented. (auth)

39887 NUMERICAL SOLUTION OF THE BOLTZMANN INTEGRAL EQUATION: A MULTIGROUP BENCHMARK CALCULATION. Lathrop, K. D. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 33: 255-7(1968).

Three finite difference approximations for the solution of the GODIVA benchmark problem by the Boltzmann integral equation are presented. (auth)

39888 IRRADIATION APPARATUS. Humphries, John R. Jr. (to Gulf General Atomic Inc.). U. S. Patent 3,378,448. Apr. 16, 1968. Filed Mar. 9, 1966.

A nuclear reactor is described having an annular rack for supporting specimens to be irradiated. The rack surrounds the core and it is movable circumferentially by mechanical drive. It is movable axially by flotation tanks which may be selectively filled with liquid or gas. Both the core and the support rack are suspended from a movable bridge and are movable together in the tank with the bridge in order that the core may be positioned adjacent irradiation facilities at each end of the tank. (Offic. Gaz.)

39889 REACTOR SYSTEM FOR GAMMA IRRADIATION. Mittelman, Phillip S. (to United Nuclear Corp.). U. S. Patent 3,378,447. Apr. 16, 1968. Filed Feb. 9, 1966.

A method for utilizing a nuclear reactor as a gamma ray irradiator is described. A swimming-pool reactor is used in a cyclic operation to irradiate a gamma emitting material. The material is exposed to the reactor core surface by horizontal access tubes. (TSS) (Offic. Gaz.)

Production Reactors

39890 APPARATUS FOR MEASURING INCREMENTAL RADIAL DISPLACEMENT OF A CHANNEL WALL. Brenden, Byron B.; Spanner, Jack C. (to United States Atomic Energy Commission). U. S. Patent 3,387,370. June 11, 1968.

Described is an apparatus for measuring bowing in long tubes such as nuclear-reactor process tubes, which apparatus comprises two rods with enlarged ends coupled in a universal joint by a flexible wire, a linear differential transformer located within one of the rods on its axis, and a rigid wire attached to a movable core of the transformer and extending through the one rod and connected to an adjacent end of the other rod at a region therewithin but offset from its axis. (AEC)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 37900, 38164, 38597, 38599, 38611, 38618, 39541, 39544, 39546–39548, 39551, 39553, 39556, and 39558.

39891 (AAEC/TM-455) FORTRAN II–FORTRAN IV CONVERSION OF METHUSELAH. Van Klink, K. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1968. 43p. Dep.

The processes involved in translating an IBM 7090 Fortran II program, Methuselah II, to an IBM 360-50H Fortran IV program are described. The program has its own comprehensive nuclear data library and may be used to calculate cell reactivity and burn-up for a very wide range of liquid-moderated reactors. It is particularly valuable for broad-range nuclear performance surveys. Problems which had to be overcome in the translation of Methuselah include language differences, machine differences and operating differences. These differences are detailed and thorough description of data preparation as required with the 360-50H is included. (auth)

39892 (AD-663882) BASIC ASPECTS OF CRACK GROWTH AND FRACTURE. Irwin, G. R.; Krafft, J. M.; Paris, P. C.; Wells, A. A. (Naval Research Lab., Washington, D. C.). Nov. 21, 1967. 82p. (NRL-6598). CFSTI.

A near approach to absolute fracture safety in boiling water and pressurized water nuclear reactor pressure vessels requires a very conservative fracture control plan. Such a plan must assume that any plausible cracklike defect, which has not been proved absent by inspection, may exist in the vessel. Requirements for design, materials, and inspection may then be established in a conservative way relative to estimates of progressive crack extension behavior. These estimates are assisted by elastic and plastic methods of analysis of cracks in tension. Approximate methods of assigning K sub Lc values to measurements of crack toughness in terms of a brittle-ductile transition temperature are valuable in reviewing methods of fracture control which have received trial in the past, such as the NRL fracture analysis diagram and the leak-before-break toughness criterion. (auth)

39893 (BNL-50082, pp 25-6) EVALUATION AND TECHNICAL ASSISTANCE GROUP. Raseman, C. J. (Brookhaven National Lab., Upton, N. Y.).

Activities of BNL personnel in power reactor technical and economic evaluations, review of Liquid-Metal Fast Breeder Reactor Program plans, High Flux Beam Research Reactor reactivity calculations, and magnetohydrodynamics studies are briefly reviewed. (H.D.R.)

39894 (BNWL-SA-1920) ESTIMATION OF WEIBULL PARAMETERS FROM FAILURE DATA. Jaech, John L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 12, 1968. Contract AT(45-1)-1830. 15p. (CONF-680807-1). Dep. CFSTI.

From Annual Meeting of the American Statistical Association, Pittsburgh, Pa.

Reactor fuel element failure data, which is used for determination of parameters for the Weibull density function, are tabulated. Use of a non-parametric estimation of failure rate is discussed. A method for estimation of Weibull parameters is proposed; uncertainty limits are evaluated. A numerical example is given. (M.L.S.)

39895 (DUN-4136) MATHEMATICAL BASIS OF COMPUTER CODE RIBD. Gumprecht, R. O. (Douglas United Nuclear, Inc., Richland, Wash.). June 17, 1968. Contract AT(45-1)-1857. 24p. Dep. CFSTI.

A brief description of the operation and mathematical basis of the computer code RIBD (Radio Isotope Buildup and Decay) which has been in use at Hanford for several years in analyzing the fission product content of irradiated reactor fuel in terms of potential biological hazards and heating effects accompanying radioactive decay. (auth)

39896 (EUR-3927) MACACO-PREST: AN ANALOG MODEL AND A DIGITAL CODE FOR CONTAINMENT STUDIES. Gaggero, G.; Gerini, P. M.; Leoni, G.; van Erp, J. B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1968. 144p. Dep.

A mathematical model is presented for the determination of pressure and temperature transients inside the containment building, following a loss-of-coolant accident due to a rupture in the primary cooling system of a nuclear power plant having water as the primary coolant. The model includes the calculation of the radiation doses incurred to the thyroid due to inhalation of radioactive iodine released outside the containment building as a function of height of release, time of exposure, distance, etc. The model in its present form is limited as regards its application to dry containment systems without pressure relief. The mathematical model was first used in conjunction with an analog computer (MACACO = Modello Analogico CAlcolo COntenitore); and was subsequently programmed and extended for digital computer use (code: PREST), for more rapid availability as a computation tool for routine evaluations. (auth)

39897 (EUR-3936) CALCULATION OF THE ABSORPTION AND FISSION RESONANCE INTEGRALS OF ^{235}U BY A FITTING PROCEDURE. De Haan, W.; Stramaccia, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1968. 34p. Dep.

A fitting procedure has been set-up to evaluate quickly the resonance integrals of fissile nuclides in multigroup neutron calculation models. For this purpose, the results of resonance integrals calculated by the refined numerical Nordheim method (ZUT and TUZ codes) are fitted into a formula based on the classical resonance theory, thus determining for each nuclide and type of event a set of parameters (three) dealing with the energy group considered. The ^{235}U values are presented for the energy group scheme of the lattice code PINOCCHIO. (auth)

39898 (EUR-3937) ANISOTROPIC COLLISION PROBABILITIES IN GENERAL CYLINDRICAL GEOMETRY. Amyot, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1968. 26p. Dep.

Based on the work of Takahashi for one-dimensional systems, a general formalism is presented for anisotropic collision probabilities in general cylindrical geometry. The method is based on an expansion in spherical harmonics of fluxes, sources, cross-sections, and collision probabilities. The resulting expressions for the zeroth and first order collision probabilities are simply related respectively to the classical isotropic collision probabilities and the directed probabilities used by Benoist in his thesis on the diffusion coefficient. (auth)

39899 (EUR-4031) COMPORTEMENT DES CRAYONS COMBUSTIBLES DE CARBURE D'URANIUM GAINES DE SAP. ETUDE THEORIQUE. (Behavior of Uranium Carbide Fuel Rods Sap Cladded. Theoretical Study). Charrault, J. C.; Fantozzi, M.; Huber, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1968. 74p. (In French). Dep.

The behavior of uranium carbide (UC) fuel rods clad with SAP (Sintered Aluminum Powder) in the reactor has been given a mathematical formulation programmed on the 360 IBM computer, under the name of Code CRAYON. Two versions are now available of this code: CRAYON G1 for rods having a gas bonding between fuel and cladding; and CRAYON L1 for rods having a liquid bonding. The principal results drawn from the application of the two versions of this code are described. These results appear mainly in the form of fuel burn-up at clad rupture as functions of the different operational and manufacturing parameters. (auth)

39900 (GAMD-8325) COATING CONTAMINATION IN FUEL PARTICLES. Selleck, E. (Gulf General Atomic, Inc., San Diego, Calif.). May 15, 1968. Contract AT(04-3)-167. 29p. Dep. CFSTI.

An evaluation of uranium contamination in pyrolytic carbon and SiC coatings on UC_2 and $(Th,U)C_2$ fuel pellets is presented. The effects of coating temperatures on contamination are described. Analysis of annealing time effects on barium and strontium release is discussed. (D.C.C.)

39901 (KAPL-P-3431) NOVA: A MODULAR PROGRAM SYSTEM FOR REACTOR PHYSICS STUDIES. Lubert, M.; Schunicht, B. F.; Kazmierczak, E. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 12, 1968. Contract W-31-109-eng-52. 8p. (CONF-680601-26). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The NOVA computer system is described; this system is a collection of reactor physics, mathematics, engineering, and data reduction modules. The NOVA system consists of about 150 Fortran modules, and is structured for user/computer interaction optimisation. A list of problems, for which the NOVA system can be used, is given. Problems encountered with the NOVA format are discussed. (M.L.S.)

39902 (KAPL-P-3432) APPLICATION OF MONTE CARLO METHODS IN REACTOR PHYSICS. Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1968]. Contract W-31-109-eng-52. 26p. (CONF-680601-27). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

General descriptions of the DRAM and MORSE Monte Carlo codes are given; code capabilities for problem solving are tabulated. Monte Carlo applications to reactor physics calculations are described. Use of Monte Carlo techniques for checking analytic methods is discussed; the simulation of experimental configurations is described; use of Monte Carlo methods in analysis of basic nuclear data is evaluated. Calculation of criticality of thermal reactors is shown as a function of generation number;

comparisons of measured-to-calculated values for neutron absorption in ^{10}B-poisoned reactor fuel elements are tabulated. (M.L.S.)

39903 (KFK-741) NUMERISCHE UNTERSUCHUNGEN ZU METHODEN DER KRITIKALITAETS- UND BRUTRATENBERECHNUNG FUER REAKTOREN MIT ZYLINDERGEOMETRIE UND TEILWEISE EINGEFAHRENEN REGELSTAEBEN. (Numerical Investigation of the Methods of Calculation of Criticality and Breeding Ratio for Reactors with Cylindrical Geometry and Partially Inserted Control Rods). Schwetje, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar. 1968. 33p. (In German). (EUR-3723). Dep.

Calculations of eigenvalues in R-θ and R-Z coordinates are tabulated as a function of geometric variations for cylindrical reactors; sample geometries are shown. The calculations are performed by sectioning the control rod into rings of graduated thickness. Use of this method for integral approximations is discussed. Calculations which determine the effects of control rods on breeding rate are tabulated. (M.L.S.)

39904 (N-68-14986) ESTABLISHING ALLOWABLE TEMPERATURE GRADIENTS FOR TUNGSTEN-URANIUM DIOXIDE FUEL ELEMENTS USING EXPERIMENTAL CYCLIC STRAIN DATA. Fiero, Ivan B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1968. 36p. (NASA-TN-D-4279). CFSTI.

To establish allowable limits for temperature difference in tungsten-uranium dioxide fuel elements, experimental thermal strain data were examined. The data were obtained by uniformly heating tungsten and tungsten-uranium dioxide composites for 50 thermal cycles. Since the materials were not cycled to failure, the allowable temperature differences established from the experimental data are not absolute maximum values, but represent design values with which fuel element configurations can be evaluated. These allowable temperature differences are those which would produce thermal strains equivalent to the experimental data. If the strains calculated for a given design are less than the experimental values, the fuel element should operate satisfactorily under the conditions considered. (auth) (STAR)

39905 (N-68-21705) HOT ISOSTATIC COMPACTION OF TUNGSTEN-URANIUM DIOXIDE FUELS WITH HIGH-VOLUME FRACTION OF URANIUM DIOXIDE. Sikora, Paul F.; Millunzi, Andrew C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 19p. (NASA-TM-X-1563). CFSTI.

Dense (>98 percent of theoretical) W-UO_2 cermets containing 30 to 70 volume percent UO_2 were fabricated by hot isostatic compaction of W-coated UO_2 particles. Both thin plates (0.020-in. or 0.051-cm thick) and small-diameter rods (0.20-in. or 0.51-cm diam) were successfully produced at compaction conditions of 3100°F (1700°C) and 30,000 psi (207 Mn/m^2). In addition to volume-fraction loading of UO_2, other variables studied in this program were the effect of fuel particle size in the range of 50- to 110-micron diameter, molybdenum or a molybdenum alloy (TZM) in container assemblies, and compaction schedule and pressure (up to 42,000 psi or 295 MN/m^2). Fully dense cermets were produced with all combinations of the range of variables studied. The surface smoothness of the cermets was affected only by the choice of container materials. Containers produced from TZM resulted in smooth cermet surfaces; however, unalloyed molybdenum containers often resulted in irregular surfaces. The feasibility of applying a thin tungsten cladding to the cermet surfaces as an integral part of the compaction process was also demonstrated. (auth) (STAR)

39906 THERMAL NEUTRON SPECTRA IN A HETEROGENEOUS LATTICE. II. NUMERICAL CALCULATION. Hron, M.; Grmela, M. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 220-5(July 1968). (In Czech).

The method of thermal neutron energy spectra calculation in a heterogeneous lattice based on integral form of transport equation is described. The relations for basic terms of the equation are presented and procedure of numerical calculation is analyzed in detail. The examples of results and comparisons with other calculations and experimental values are presented. (auth)

39907 LEGISLATIVE PRESCRIPTIONS FOR PRESSURIZED EQUIPMENT. Van der Laken, R. A. (Reactor Centrum Nederland, Den Haag, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 25, 61-70(1968). (In Dutch).

Until recently the legislative directives for nuclear reactor safety were only based upon the "Steam Act" of 1953 and the "Steam Regulation" of 1953. A "Provisional Review Rule" (VBR) is enforced, dealing with the design of nuclear installations and their components. The VBR recommends the calculation of stresses according to the Huber-Hencky method. If no theoretical methods are available, the VBR requires experimental work. The VBR divides stresses as primary ones, caused by external loads, and secondary ones, caused by deformation of the material during construction. Several subcategories, simplifying the process of determining the admissible stress and the required material strength, are discussed. (J.J.t B.)

39908 SELECTION PRINCIPLES OF NUCLEAR REACTOR CONTAINMENT. Palmieri, Domenico. Calore, 38: 525-38 (1967). (In Italian).

An indication of most generally applied technical rules for the planning of nuclear reactor containment is provided. The point of view which must be assumed by the designer during the first planning is described. The two fundamental parameters of the loss rate and the pressure are discussed. The first parameter is studied in its normal value for planning purpose, in the elements that mostly exert influence on it and in the more common procedures for its valuation. As far as the second parameter is concerned, some considerations useful to simplify the problem are presented. (auth)

39909 APPENDAGES FOR NUCLEAR REACTORS. Leutscher, H. (NV Dikkers and Co., Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 25, 83-94(1968). (In Dutch).

The advantages and disadvantages of forged versus cast steel values are discussed; the latter are preferred. These are preferably made of austenitic steel; moving parts are coated with a Co-Cs-alloy to prevent wear. Several methods of preventing leakage are discussed. (J.J.t B.)

39910 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ASSEMBLIES. Seddon, Thomas; Chetter, John (to United Kingdom Atomic Energy Authority). British Patent 1,117,237. June 19, 1968. Filed Oct. 30, 1964.

The description of a nuclear reactor fuel assembly is presented. The fuel assembly consists of a cluster of spaced parallel fuel rods, a spacer grid of crossing wires or rods, and closed circular loops at the grid intersections to form fuel element supports. The wires or rods of the grid are secured to a surrounding support framework by ferrules. The tension in the grid wires on rods is variable. (D.C.C.)

39911 THERMAL INSULATION FOR NUCLEAR REACTORS. Smith, Henry Thomas (to Cape Asbestos Co. Ltd.). British Patent 1,117,231. June 19, 1968. Filed July 20, 1964.

The description of thermal insulation for a spherical reactor is presented. The thermal insulation consists of triangular blocks of asbestos, Ca_2SiO_4, or foamed concrete. The blocks are enclosed in stainless steel or Al cases. Each block has a breather hole covered with fine gauge. (D.C.C.)

39912 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ASSEMBLIES. Seddon, Thomas; Chetter, John (to United Kingdom Atomic Energy Authority). British Patent 1,116,811. June 12, 1968. Filed Oct. 30, 1964.

A description of a fuel assembly support structure for a nuclear reactor is presented. The fuel assembly consists of a cluster of parallel fuel rods, a spacer grid of multiple octagonal cells, and a grid boundary support. The fuel rods are supported inside the grid by four opposing dimples formed from non-secured sides of the octagon. The dimples function as leaf springs. The octagon cells are fastened on four sides to other cells by spot welding. (D.C.C.)

39913 IMPROVEMENTS IN NUCLEAR REACTORS AND FUEL AND OTHER ELEMENTS THEREFOR. Koller, Victor Paul; Shaw, James William Westgarth (to United Kingdom Atomic Energy Authority). British Patent 1,119,413. July 10, 1968. Filed May 10, 1965.

A description of a reactor loading machine is presented. The loading machine is pressure vessel-enclosed with internal electric drives. The machine operates with an electric motor and a spool-wound cable. The cable is connected to the fuel element by a sling mechanism. The fuel elements are raised and lowered through a standpipe. The loading machine is movable in the pressure vessel from a central penetration point. (D.C.C.)

39914 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Seymour, Stanley Charles (to English Electric Co. Ltd.). British Patent 1,119,263. July 10, 1968. Filed Jan. 22, 1965.

The description of a fuel element-connected thermocouple is presented. The fuel element includes a metallic can with radial splitter fins. The thermocouple hot junction is attached to a fin with the cable passing along the assembly to a prescribed location. To remove the thermocouple cable, tension is applied until

the cable snaps at the middle point on a free loop section. Guide plates with narrowing separation are attached to a fin and straighten the cable as it is being withdrawn. (D.C.C.)

39915 NUCLEAR REACTOR COOLING DUCT OR PRESSURE TUBE WITH SOLID INTERNAL INSULATION. Dufresne, Jacques; Casali, Flaviano Farfaletti; Volta, Giuseppe (to European Atomic Energy Community). British Patent 1,119,469. July 10, 1968. Priority date June 14, 1966, Italy.

A description of a pressure tube for a nuclear reactor is presented. The pressure tube consists of a tube with a series of hollow cylinders surrounding it for internal heat insulation. The cylinders are composed of sectors joined along the longitudinal edges. The ends of the adjacent cylinder sectors are joined by pressure rings connected to the pressure tube. The pressure rings are T-shaped connectors. (D.C.C.)

39916 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Stephen, David Ramsey (to United Kingdom Atomic Energy Authority). British Patent 1,119,620. July 10, 1968. Filed Oct. 3, 1966.

A description of a plate-type fuel element assembly is presented. The fuel element assembly consists of multiple plates having opposite edges supported by teeth tapering toward the fuel plates. The plates are curved rectangular members arranged in parallel. (D.C.C.)

39917 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS, IN PARTICULAR FOR NUCLEAR REACTORS. Legrand, Pierre British Patent 1,119,724. July 10, 1968. Priority date Oct. 6, 1964, France.

A liquid-liquid type heat exchanger is described. The heat exchanger consists of a close-packed nest of straight and parallel tubes in a hexagonal lattice. The tubes are arranged in bundles with a central tube and six connecting tubes in a sheet or layer configuration. The connecting tubes are joined to the central tube by lateral tubes at their ends. The central tube contains lateral tubes at each end for inter-bundle connections. The tube bundles are supported from the lower end by the central tubes. (D.C.C.)

39918 REACTOR CALORIMETER CALIBRATION THEORY. Kott, Josef (Nuclear Power Plant Div., Plzen, Czech.). Jad. Energ., 14: 56-63(Feb. 1968). (In Czech).

The complete reactor calorimeter calibration theory, the manner of thermal energy accumulation as a result of the reactor radiation influence in matter, reactor calorimeter thermal leakage analysis, relations in the calorimetric sample, and the reactor calorimeter operation regime are discussed. Temperature distribution differences of calibration and radiation heating inside the calorimeter sample with special attention to the adiabatic and isothermal operation are described. Relations for the calibration analysis of the cooling curves after the radiation heating inside the reactor are discussed. A summary of time criteria for determining the equivalents between the calibration and radiation heating of materials for comparative calculations is presented. (auth)

39919 CALCULATION OF NONSEPARABLE REACTOR GEOMETRIES USING THE EXPANDED FLUX SYNTHESIS METHODS. Schaeffler, Hermann (Technische Hochschule, Stuttgart). Nukleonik, 11: 91-5(May 1968). (In German).

Multigroup diffusion theory is used to formulate matrix expressions for the neutron flux. These expressions are then used in the expanded flux synthesis technique to describe two- and three-dimensional special reactor configurations in rectangular coordinates having partial absorber plates. (M.L.S.)

39920 EXPANDED FLUX SYNTHESIS METHOD. Schaeffler, Hermann (Technische Hochschule, Stuttgart). Nukleonik, 11: 84-9(May 1968). (In German).

Multigroup theory is used as the basis for the kinetics equations for cylindrical reactors having discrete control rods. The effects of these control rods on the neutron flux are determined directly; an expanded flux synthesis technique is used to reduce the number of unknowns in the final system of differential equations. An example problem is given. (M.L.S.)

39921 CONTROL ARRANGEMENT FOR A NUCLEAR REACTOR. McDaniels, John D, Jr. (to Babcock and Wilcox Co.). U. S. Patent 3,390,052. June 25, 1968. Filed Mar. 12, 1965.

A control member actuating arrangement for a nuclear reactor having a core and having control members movably captured in tubes is described. The actuator includes nozzles spaced apart from the lower end openings of the tubes for ejecting control fluid into the tubes against the control members to drive the members substantially axially of the tubes and out of the reactor core. (Offic. Gaz.)

39922 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Ziegler, Albert (to Siemens Aktiengesellschaft). U. S. Patent 3,389,516. June 25, 1968. Priority date Mar. 6, 1964, Germany.

A prestressed concrete pressure vessel for nuclear reactors has a cylindrical wall opening both ends formed by an assembly of prefabricated concrete segments spaced circumferentially one from the other so as to define a plurality of gaps filled with pressure-resistant material, and annular prestressing means for prestressing the concrete segments. The cylindrical wall has a cylindrical outer surface on which the annular prestressing means are disposed and a cylindrical inner surface located intermediate to respective regions adjacent the open ends of the cylindrical wall, the prefabricated concrete segments at those regions being formed with bracing surface. Also provided are wedge-shaped support members having surfaces engageable with the bracing surfaces and extending radially inwardly of the cylindrical wall, the support members being also formed with bearing contact surfaces. End blocks are inserted in the open ends and are provided with conical surfaces engageable with the bearing contact surfaces for closing the open ends of the cylindrical wall. The bracing surfaces are in substantially stepwise arrangement and are at least partly parallel to the conical surfaces of the end blocks. At least one of the wedge-shaped support members may consist of two side portions and a middle portion, the middle portion lying substantially in a plane passing through the longitudinal axis of the cylindrical wall and having parallel side surfaces respectively adjacent the side portions. (Offic. Gaz.)

39923 SKEWED HELICAL WART SPACERS FOR FUEL ASSEMBLIES. McGregor, John C.; Bates, Kenneth T. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,389,057. June 18, 1968. Filed Apr. 14, 1967.

A fuel rod structure for a nuclear reactor is described in which the elements making up the rod are assembled in a cluster in which each element is separated from its adjacent elements by a wart or spacer on the sheath of each element in the region where it will contact the wart of an adjacent element. The warts are of elongated form and each has its longitudinal axis of the element to which it is attached. By this means the warts engage one another in crossed-orientation and contact one another over greater limits of lateral or longitudinal offset from their planned position on the elements. Preferably the warts have their longitudinal axes placed on helices whose axes are in the same direction as the longitudinal axes of the elements and in which all helices are in the same sense for all elements in the cluster. (Offic. Gaz.)

39924 SOME REMARKS ABOUT SETTING UP A MODEL FOR OPTIMAL CONTROL OF NUCLEAR SYSTEMS. Caligiuri, G. P. Automaz. Strum., 15: 504-5(Nov. 1967). (In Italian).

The possibility of taking nuclear systems to power equilibrium states along different control strategies sets up the problem of research on the strategy among admissible ones that in such a transit satisfies some optimizing criterium. Constraints on state and control vectors are: maximum available reactivity in the core; maximum admissible reactivity variation in time due to control rods; minimum reactor period. A model is suggested as suitable to be treated with Pontryagin maximum principle. Obtainable solutions can be of some interest especially for nuclear systems where power variations are frequent. (UK)

39925 FUEL ARRANGEMENT FOR A NUCLEAR REACTOR. Frisch, Erling (to Westinghouse Electric Corp.). U. S. Patent 3,377,254. Apr. 9, 1968. Filed Dec. 1, 1961.

A nuclear fuel assembly is provided containing a bundle of elongated fuel rods arranged in a longitudinally parallel array. The fuel rods are supported and are laterally positioned relative to one another by at least one grid member and are prevented from substantial longitudinal movement by a pair of plate members positioned outwardly of the ends of the fuel elements. Means are provided for positioning the grid member between the plate means. The grid positioning means includes at least one elongated member secured to each of the plate means and extending through one of the openings in the grid member. In one example of the invention, the grid supporting means comprises a plurality of tie rods. (Offic. Gaz.)

39926 NUCLEAR REACTORS. Knights, Herbert Chilvers (to United Kingdom Atomic Energy Authority). U. S. Patent 3,377,252. Apr. 9, 1968. Priority date Aug. 17, 1965, Great Britain.

A nuclear reactor core comprises plural individual core units, each core unit including both fuel and a movable reactivity controlling assembly. There is an operating assembly for each controlling assembly, each controlling assembly having attachment means for engagement by the operating assembly. Each core unit includes within the unit lock means for holding its controlling

assembly during transport and handling against movement away from an initial low reactivity position. Cooperating means on the lock means and the associated operating assembly release the lock means as the operating assembly engages the attachment means of the controlling assembly. Only on assembly into an operational core is there a freeing of the lock to enable achieving a critical state in the core. (Offic. Gaz.)

39927 JET PUMP ASSEMBLY IN A NUCLEAR REACTOR. Hughes, Donald E. (to General Electric Co.). U. S. Patent 3,389,055. June 18, 1968. Filed Apr. 5, 1965.

A system of jet pumps for circulating a cooling fluid such as water through a nuclear reactor core contained within a pressure vessel is described. The jet pumps are located in the downcomer annulus between a shroud surrounding the core and the interior of the pressure vessel whereby the coolant is forced downward into the inlet end or bottom of the core. The nozzles of the pumps are supplied with driving fluid via a distributor near the bottom of the vessel and riser pipes extending upward adjacent the pumps. The jet pump nozzles are supported by an adjacent riser pipe and each nozzle is formed with wings for engaging the respective pump inlet. Each pump body is formed with a slip joint to permit ready removability of the upper or mixer section of the pump. The pump body has a higher thermal coefficient of expansion than the riser pipes whereby the nozzle wings and pump inlet and the slip joint are more firmly forced together with an increase in temperature. (Offic. Gaz.)

39928 GRIPPER FOR A LOADING MACHINE OF A NUCLEAR REACTOR. Johnsson, Erik Boerje; Froeman, Karl Goeran Ernst (to Aktiebolaget Atomenergi). U. S. Patent 3,388,942. June 18, 1968. Priority date May 24, 1965, Sweden.

A description of a gripper for a reactor loading machine is presented. The loading machine operates in a vertical overhead position. The gripper consists of two lifting hooks which are operated by a rotating member. The rotating member is connected to a wire which operates the member by lowering or raising the loading machine. (TSS) (Offic. Gaz.)

39929 FUEL ASSEMBLIES. Frisch, Erling (to Westinghouse Electric Corp.). U. S. Patent 3,389,056. June 18, 1968. Filed July 9, 1964.

An orificed fuel assembly for a nuclear reactor is described. The fuel assembly consists of multiple elongated thin walled tubes with rectangular cross section. The tubes are joined at common points to form a lattice. Each tube consists of a fuel element bundle, a coolant inlet nozzle, an orifice for flow control, and multiple projecting tabs for support. (TSS) (Offic. Gaz.)

39930 SPATIALLY DEPENDENT RESONANCE NEUTRON SPECTRA IN A SLAB OF DEPLETED URANIUM. Antunez, H. M.; Neill, J. M. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 33: 238-48(1968).

Neutron spectra are measured by the time-of-flight method from 1 eV to 2 keV at various positions across depleted uranium and borated polyethylene in slab geometry with an energy resolution of 0.9% at 6.68 eV. The observed behavior around the 6.68 eV resonance in ^{238}U is compared with the predictions of the transport theory code 1DF in S_4 and S_8 approximations using different quadratures and spatial representations. The space-averaged flux is calculated with the slowing down code GAROL. The 1DF calculations agree reasonably well with experiment and the GAROL values. (auth)

39931 OPTIMAL CONTROL OF XENON-POWER SPATIAL TRANSIENTS. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 33: 162-8(1968).

The problem of controlling Xe-power spatial transients in a large thermal power reactor is formulated in terms of the dynamic programming formalism. This formulation results in a computing algorithm that can be used to select the control action that optimizes some performance index from among a predetermined set of allowable control sequences. An application of this formalism to a relatively detailed three-dimensional reactor model is presented. (auth)

39932 EXTRAPOLATION DISTANCE FOR A BLACK OR GREY CYLINDRICAL NEUTRON ABSORBER BY THE SPHERICAL HARMONICS METHOD. Pellaud, Bruno (New York Univ., N. Y.). Nucl. Sci. Eng., 33: 169-86(1968).

The linear extrapolation distance, extrapolated endpoint, and effective radius of grey and black cylindrical neutron absorbers imbedded in an infinite moderator have been calculated using Kofink's formulation of the P_N method, with N odd up to 13. These parameters were determined as functions of the absorption of the moderator and of the linear anisotropic scattering component of the moderator, for two source distributions: uniform isotropic sources; or no sources with a current from infinity. The results are given both in tabular form and in simple formulas that are sufficiently accurate for most purposes. In addition, various kinds of P_N boundary conditions are compared and new calculations are given for the blackness of homogeneous grey rods. (auth)

39933 APPLICATION OF VARIATIONAL SYNTHESIS TO THE OPTIMAL CONTROL OF A POINT REACTOR MODEL. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 33: 257-60(1968).

The techniques of variational synthesis are applied to obtain a solution for the optimum reactivity control of a point reactor model, with temperature feedback, subject to a general type of optimizing function. An integral equation formulation of the neutron dynamics allows the solution of a two-point boundary value problem that is frequently associated with the differential equation formulation of the optimal control problem to be replaced with a system of algebraic equations. (auth)

39934 ITERATIVE METHOD FOR EVALUATION OF PERIOD MEASUREMENTS IN A REACTOR CONTAINING AN INTRINSIC NEUTRON SOURCE. Habermann, F. W. A.; Walze, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 33: 264-5(1968).

The measurement of asymptotic reactor periods is still an important method of determining reactivity. To enable high-precision asymptotic period measurements at a low power level, a method of analysis is described that eliminates the influence of large neutron sources. (auth)

39935 CONCERNING "AN OPTIMAL CONTROL OF A DISTRIBUTED-PARAMETER REACTOR". Kyong, S. H. (Bell Telephone Labs., Whippany, N. J.). Nucl. Sci. Eng., 33: 270 (1968).

Clarification of conditions regarding the integral equation used for optimum control criteria is presented. (D.C.C.)

39936 VARIATIONAL APPROACH TO THE SELECTION OF THE DIRECTION SETS IN THE DISCRETE S_n APPROXIMATION TO NEUTRON TRANSPORT THEORY. Jauho, Pekka; Kalli, Heikki (Technical Univ. of Helsinki). Nucl. Sci. Eng., 33: 251-4(1968).

The discrete S_n method for solving the neutron transport problems is analyzed by discrete ordinates method; the directional neutron flux is approximated by a finite number of neutron rays with certain weights. The scalar flux is treated by S_n solution; discrete directions and weights are treated as free parameters. Two variational formulations are used: the integral transport equation; and self-adjoint variational formulation for monoenergetic Boltzmann equation by Toivaners. (auth)

39937 COATED FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Vivante, Claudio (EURATOM, Geel, Belg.). Euratom Rev., 7: 46-51(June 1968).

The processes for fabricating fuel kernels of uranium and thorium carbide or oxide mixtures and then coating them with pyrolytic carbon are reviewed. Irradiation testing of the coated-particle fuels is discussed, and the performance of these fuels at high temperatures for retention of fission products is examined. (H.D.R.)

39938 LIQUID-COOLED NUCLEAR REACTOR WITH COUNTER-FLOW BRAKE DEVICE. Wright, James Rostron (to United Kingdom Atomic Energy Authority). U. S. Patent 3,386,885. June 4, 1968. Priority date June 28, 1965, Great Britain.

A core support structure of a liquid-cooled nuclear reactor has interposed in each of the passages by which the coolant passes from an inlet plenum to fuel-containing channels a hydraulic counterflow brake device arranged to resist reverse flow toward the inlet plenum. This limits to a single channel the voiding of coolant which may occur because of the surge of released gas upon a sudden and large scale reservoir failure in fuel members of the type which have fission product gas reservoir spaces adjacent to the inlet ends of the channels. (Offic. Gaz.)

39939 FLEXIBLE SPACER FOR A NUCLEAR REACTOR FUEL ASSEMBLY. Tarasuk, Walter R.; Bessey, Pleman E.; Scholfield, Paul D. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,390,053. June 25, 1968. Priority date Dec. 31, 1965, Canada.

A fuel rod assembly for a nuclear reactor is described in which the elements have thin metal sheaths and a flexible spacer separates the elements. The spacer consists of a wire bent to form a pair of attachment portions to the sheaths of adjacent elements with a transverse portion joining the two attachment portions. The attachment portions are secured to the sheaths of adjacent elements such as by welding with the point of attachment offset from

the line of action of force acting through the transverse portion. (Offic. Gaz.)

39940 NUCLEAR FUEL ARRANGEMENT. Fiebelmann, Peter (to EURATOM). U. S. Patent 3,378,454. Apr. 16, 1968. Priority date Sept. 17, 1965, Germany.

A nuclear fuel arrangement is described in which the fuel is divided into parallel strips, the interspace between the strips forming gas-tight chambers which contain a liquid metal heat carrier and have capillary grooves on the chamber walls extending transversely to the axis of the strips. The chambers thus act as heat pipes which transport thermal energy in a radial direction. (Offic. Gaz.)

39941 IMPROVEMENTS RELATING TO FUEL HANDLING MEANS IN NUCLEAR REACTORS. Burcher, George Davey (to Fairey Engineering Ltd.). British Patent 1,119,262. July 10, 1968. Filed July 8, 1964.

A description of a pressure lock system for a fuel element loading machine of a nuclear reactor is presented. The pressure lock system consists of a tube with an upper section mounted permanently and a movable lower section. The upper section has a removable plug. The lower section is secured to the upper section by power-driven jacks. With the lower end of the tube in place under the upper end, a fuel element is lowered into the tube. With the plug replaced, the lower end moves to a portion in a storage pool with vertical access equipment. (D.C.C.)

39942 GRAPHITE STRUCTURES IN NUCLEAR REACTORS. Bridge, Harry; Kelly, Brian Thomas (to United Kingdom Atomic Energy Authority). U. S. Patent 3,378,459. Apr. 6, 1968. Priority date Jan. 12, 1962, Great Britain.

A graphite moderator is described which contains a varying composition graphite region that allows thermal expansion to compensate for neutron radiation effects. The varying graphite compositions with different coefficients of thermal expansions are selected to form dimensional stability in the moderator structure. (TSS) (Offic. Gaz.)

39943 METHOD AND APPARATUS FOR RECOVERING BORIC ACID IN NUCLEAR REACTOR PLANTS CONTROLLED WITH BORIC ACID. Graemer, Gottfried; Kausz, Ivan (to Siemens Aktiengesellschaft). U. S. Patent 3,378,450. Apr. 16, 1968. Priority date Jan. 14, 1966, Germany.

A boric acid recovery loop for a boric acid-controlled nuclear reactor is described. The parallel connected loop consists of a purifier connected with a series arrangement of an intermediate tank, a rectification column, an after-purifier, a supply tank for boric acid solution, a buffer and mixer tank, and a clear water supply in parallel connected between rectification and buffer and mixer tank. (Offic. Gaz.)

39944 EMBOSSED CLADDING FUEL ELEMENT AND MANUFACTURING PROCESS THEREFOR. (to United States Atomic Energy Commission). British Patent 1,120,934. July 24, 1968. Priority date Jan. 28, 1965, United States.

A method for fabricating an embossed fuel element for a nuclear reactor is presented. The fuel element consists of a thin-walled metallic tube filled with fissile material. The fissile material is compacted until the desired density is obtained. The stainless steel or zirconium tube is then passed through rolling wheel male dies where compressive forces are exerted. The compressive forces form helical grooves simultaneously and serially along the longitudinal axis of the tube. (D.C.C.)

39945 CORE STRUCTURE FOR SOLID-MODERATOR NUCLEAR REACTORS. Rouge, Pierre; Vivien, Jean (to Commissariat a l'Energie Atomique). British Patent 1,120.053. July 17, 1968. Priority date Mar. 12, 1965, France.

A description of a solid moderator for a nuclear reactor core is presented. The core structure consists of a support with columns of moderator superposed bricks. The core is formed from assemblies of three columns of hexagonal cross section and a channel. The columns are coupled by longitudinal keys located along two planes at an angle of 60° with respect to each other. (D.C.C.)

39946 NUCLEAR REACTOR FUEL PIN AND APPARATUS FOR SENSING DENSITY PRESSURE OR CONCENTRATION OF A GAS. Maidment, Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,120,582. July 17, 1968. Filed Apr. 14, 1965.

A description of a fission gas metering device for a fuel element is presented. The metering device consists of a void space in the fuel element where the gas is collected. A piston in the void space responds to the fission gas pressure. The piston serves as an acoustic transducer to actuate an electromagnetic chart recorder. (D.C.C.)

GENERAL

39947 (AECL-3110) ELECTROSTATIC POTENTIAL BETWEEN A CIRCULAR AND A SQUARE CYLINDER. Selander, W. N. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1968. 28p. Dep. CFSTI. CAN $1.00.

A semianalytic method is given for finding the two-dimensional potential between coaxial circular and square cylinders. Good accuracy is obtainable and numerical estimates for the maximum error are given. The capacitance of the configuration is obtained and is compared with the capacitance of related pairs of concentric circular cylinders. The results obtained are directly related to problems in heat transfer and transmission line wave propagation. (auth) (CANADA)

39948 (AECL-PAK/Lib-13) INFRARED TECHNOLOGY. A Bibliography. Rafique, M. M.; Saleem, M. (Atomic Energy Centre, Lahore (Pakistan)). Apr. 1966. 33p. Dep.

A total of 391 references to classified reports and the published literature is presented on the subject of infrared technology detectors, radiations, applications and systems, and scanners and photography. (auth)

39949 (ANL-7428) A STUDY OF SOME NUMERICAL METHODS FOR THE INTEGRATION OF SYSTEMS OF FIRST-ORDER ORDINARY DIFFERENTIAL EQUATIONS. Clark, Nancy W. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 26p. Dep. CFSTI.

A study of some numerical methods for the integration of systems of first-order ordinary differential equations which describes the extrapolation methods of Bulirsch-Stoer and Neville, presents the results of some tests comparing the extrapolation methods with the Runge-Kutta and Adams-Moulton methods, and shows some of the circumstances under which the extrapolation method may be preferred is discussed. Results of double-precision tests of the Bulirsch-Stoer method are presented to show the efficiency of various orders of this method as a function of desired accuracy. (auth)

39950 (BNL-50082) NUCLEAR ENGINEERING DEPARTMENT ANNUAL REPORT. (Brookhaven National Lab., Upton, N. Y.). Dec. 31, 1967. 196p. Dep. CFSTI.

Activities of the BNL Nuclear Engineering Department in fundamental reactor physics, chemistry, and metallurgy studies, component development for reactor technology and radiation application, and engineering and evaluation studies are reviewed. A separate abstract was prepared for each of the 8 sections included. (H.D.R.)

For abstracts of individual sections see: 37707, 37775, 37776, 37900, 38510, 39627, 39875, and 39893.

39951 (BNL-50101) TAMPERING WITH HEREDITY: THE GENETIC TRANSFORMATION OF BACTERIA BY DNA. Brookhaven Lecture Series Number 71. Lacks, Sanford (Brookhaven National Lab., Upton, N. Y.). Jan. 17, 1968. 6p. Dep. CFSTI.

The nature of DNA and its role in the molecular mechanism of bacterial transformation are reviewed. Evidence from studies with phosphorus-32-labeled DNA show that in the transformation of pneumococcus, the entering DNA is converted to equal amounts of single strands and mononucleotides. This suggests a mechanism for entry in which a cellular deoxyribonuclease degrades one strand of the DNA and thereby drags the complementary strand into the cell. The intact single strand serves as the vector of genetic information. It must find and bind to the homologous region of DNA in the recipient cell. This process may be facilitated by the hydrogen-bonding potential of the unpaired bases in single-stranded donor DNA. A segment of the donor strand then exchanges places with the homologous recipient segment. The donor material becomes integrally inserted into the recipient DNA and is thereafter replicated as part of the cell's own DNA. If the donor segment contains genetic information not hitherto present in the cell, the cell and its progeny are transformed. (auth)

39952 (BNWL-743) TRANCO: A COMPUTER PROGRAM FOR ESTIMATING THE COST OF ELECTRICAL POWER TRANSMISSION. Van Hees, L. D.; Kelley, E. L. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

The cost of electrical power transmission is usually approximately 10% of the total cost of power delivered to the consumer. Although the transmission costs less than either the generation or distribution, it is significant enough to affect powerplant siting and electrical system planning. For this reason, it is desirable to have available the means to predict with reasonable accuracy the cost of power transmission. Capital costs of electrical power transmission systems depend on the system voltage, type of terrain, year of construction, interest rate, geographic location, economic life, and a number of less important variables. Included in the capital cost are the transmission line and transmission facilities. The annual cost of power transmission is derived by combining the yearly operating expenses and capital cost. The unit transmission costs are, of course, a function of the energy transmitted over the system. The computer program described in this report not only estimates the capital cost, annual expenses and transmission cost of transmission systems, but escalates these costs to the projected construction year which makes it of greater use in electrical system planning. A computer program has been developed to estimate the cost of electrical power transmission with the line voltage, type of terrain, date of construction, interest rate, geographic location and economic life of the system treated as variables. Characteristics of thirty transmission systems under construction or which have been placed in operation across the United States since 1965 were investigated and typical lines were picked for 230 KV, 345 KV and 500 KV. From these data an equation was developed relating the costs of transmission lines as a function of voltage. The average transmission line cost per mile is broken down into material and labor in order to localize to a given region and escalate properly for the year of construction. Each of these items is broken down into a fixed expense, which is the same for all voltages, and an expense that varies with voltage. Right-of-way costs are figured on a per acre basis. Curves were drawn to relate the 1966 U. S. average transmission facility expenses for transmission systems of different voltage levels. Equations were derived from these data. Costs were broken down into the necessary components to allow escalation to be calculated. The program, from the input data of line voltage, type of terrain, construction date, interest rate, economic life and geographic location, calculates the capital cost, annual operating expenses, and transmission cost for the system with costs escalated to the year of construction. Two test cases were run, and the results agreed within 5.1% of the actual published costs. (auth)

39953 (CEA-R-3466) ANALYSIS OF ELECTRONIC CIRCUITS USING DIGITAL COMPUTERS. Tapu, Cornel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 48p. (In French). Dep.

Various programs have been proposed for studying electronic circuits with the help of computers. It is shown here how it is possible to use the program ECAP, developed by IBM, for studying the behavior of an operational amplifier from different points of view: direct current, alternating current, and transient state analysis; optimization of the gain in open loop; and study of the reliability. (auth)

39954 (EGG-1183-449) MATERIALS RESPONSE TESTS. SERIES I. Clyde, Allan (EG and G, Inc., Boston, Mass. Eastern Science and Technology Div.). Apr. 8, 1968. Contract AT(29-1)-1183. 131p. Dep. CFSTI.

Data taken by the Materials Response Laboratory, EG&G, Bedford, Massachusetts with the COGEN I electron beam machine during May of 1967 are presented. Subsequent to these tests, software techniques have been developed that allow one to extrapolate reasonably accurate beam characteristics from the limited information available in the voltage and current data taken from the COGEN center cylinder. The results quoted were calculated from these data together with an equivalent circuit to represent the load. The electron beam flux is given as a function of electron energy and time to ≲15 percent. (auth)

39955 (FFA-100) THEORETICAL INVESTIGATION OF CREEP DEFORMATION AND BUCKLING OF A CIRCULAR CYLINDRICAL SHELL UNDER AXIAL COMPRESSION AND INTERNAL PRESSURE. Samuelson, Ake (Flygtekniska Forsoksanstalten, Stockholm (Sweden)). Aug. 1964. 33p. Dep.

Thesis.

A theory is presented for the calculation of deflections and stresses, as functions of the time, in a thin circular cylindrical shell subject to axial compression and internal pressure. Elastic deformations and secondary creep are taken into consideration. The shell is represented by a "multi-membrane" shell, an extension of the "double-membrane" concept. The resulting system of partial differential equations is solved numerically in the double-membrane case, and the results are presented for several different values of the parameters involved. The possibility of predicting the critical time is discussed in detail, and an approxi-

mate method is arrived at. Comparison with available experimental results shows rather good agreement. An attempt is also made to predict the number of circumferential buckles by means of the classical buckling theory, and acceptable agreement is noted in comparison with experiments. Flow scheme and FORTRAN program for the numerical calculations are included. (auth)

39956 (ISS-67/30) IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE MAGGIO-AGOSTO 1967. (The Seminar at the Physics Laboratory During the Period May-August 1967). (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 14, 1967. 58p. (In Italian). Dep.

A synopsis of the lectures held at the Physics Laboratory of the Istituto Superiore di Sanita during the period May-August 1967 is presented. Topics included are radioprotective considerations in irradiation of organs and tissues, quantization of the Einstein field, electron scattering on nuclei, observational evidence and evolution calculations for older star generations, inducible and mutational changes in Escherichia coli ribosomes, primary structure of the alanyl-t RNA isolated from E. coli B, central potential model for calculating photoionization cross section for x ray interactions with atoms, nuclear forces, spectroscopic results and structure of liquids, spectroscopic methods for H-bonding studies, pseudopotentials and their applications, and specifications on the in vitro synthesis of proteins in species. (B.G.D.)

39957 (LA-3886) $O(h^{2n+2-l})$ BOUNDS ON SOME SPLINE INTERPOLATION ERRORS. Swartz, Blair (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. Contract W-7405-eng-36. 24p. Dep. CFSTI.

Certain spline interpolations (of odd degree) to smooth functions at uniformly spaced joints are considered. Certain cubic spline interpolations at arbitrarily spaced joints are also discussed. Good error bounds are obtained in all cases, for the errors are essentially those of a local two-point Polya interpolation. (auth)

39958 (LA-3920) INDX: A COMPUTER PROGRAM TO AID IN THE INDEXING OF X-RAY POWDER PATTERNS OF CRYSTAL STRUCTURES OF UNKNOWN SYMMETRY. Roof, R. B. Jr. (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 36p. Dep. CFSTI.

A computer program, INDX, was developed that attempts to index x-ray diffraction powder patterns by finding a reduced triclinic cell whose calculated Q values ($Q = 1/d^2$) match a desired percentage of the observed Q values within a given limit of error. If a reduced triclinic cell is found, the cell constants may be used to form a rectangular array, i.e., a Niggli matrix, and reference to published tables of general and special Niggli matrices reveals whether or not the specific triclinic cell may be transformed to a cell of higher symmetry. (auth)

39959 (LA-3923) PUBLICATIONS OF STANISLAW M. ULAM. Hendry, Barbara (comp.) (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 20p. Dep. CFSTI.

A list of 184 publications, including books, journal articles, conference papers, technical reports, and patents is presented. The list includes subjects in nuclear science, computer programs for playing chess, calculating the growth patterns of biological systems, and mathematics. (W.H.K.)

39960 (MLM-1397) QUICK-CURING FOAM SYSTEMS. Hartzel, L. W.; Brown, L. E.; Nutter, J. D.; Thomas, E. G. (Mound Lab., Miamisburg, Ohio). July 30, 1965. Contract AT-33-1-GEN-53. 74p. Dep. CFSTI.

Many formulations prepared from commercially available materials were briefly scanned in order to develop a rapid-curing foam system that would yield a satisfactory product at room temperature. The most promising of these systems were evaluated for reactivity over the temperature range from −60 to 80°C, foaming ability, and solvent resistance of the end product. Simultaneously, studies were made on the stability of components of these formulations when subjected to storage at 110°C. The effect of this aging on viscosity, refractive index, heat of reaction, and foaming ability was determined. On the basis of the above-mentioned tests, formulations were continually modified to improve their properties. The effect of the incorporation of flexible modifiers and silicone surfactants into epoxy foam formulations was investigated. The effect of increased catalyst concentration on the foaming ability of an epoxide-trimethoxyboroxine formulation at −60°C was determined; similarly, the effect of the incorporation of various solvents into this formulation was studied. The effect of inhibitors on the polymerization of furfuryl alcohol at 110°C, the effect of aging on the foaming ability of silicone surfactant SF-1079, and the efficiency of some nonsilicone foam control agents in some foam systems were briefly investigated. (auth)

39961 (MLM-1492) COMPLEMENTARY COLORIMETRIC APPROACH TO THE ANALYSIS OF CHEMICAL SYSTEMS. SUCCESSIVE FIRST ORDER REACTIONS IN FOUR DIMENSIONS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). July 5, 1968. Contract AT(33-1)-Gen-53. 21p. Dep. CFSTI.

Complementary colorimetric techniques were extended to a chemical system containing five species. The number of components contributing to the data is determined using matrix rank analysis or by complementary colorimetric techniques. The concentration of each of the five species is determined through definition of the five-sided four-solid that contains the colorimetric or radiometric data. Techniques of analytic geometry are then applied to yield equations that relate absolute concentrations. The technique is applicable both to linear systems, where the total concentration of all species is constant, and to nonlinear systems, where the total concentration of all species need not remain constant during the course of the analysis. It can also be generalized for use with systems containing an unlimited number of species. (auth)

39962 (MLM-1536) CHROMIUM(III)-ERIOCHROME BLUE BLACK R: A NEW CHELOMETRIC INDICATOR. Silver, G. L.; Bowman, R. C. (Mound Lab., Miamisburg, Ohio). May 27, 1968. Contract AT-33-1-GEN-53. 8p. Dep. CFSTI.

The preparation and some properties of a new indicator suitable for the determination of metal ions with ethylenediaminetetraacetic acid (EDTA) is described. Titrations of calcium, cadmium, manganese, and zinc illustrate the applicability of the indicator in chelometry. (auth)

39963 (NVO-99-25) 1967 COLOMBIAN EARTHQUAKES. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). May 1968. Contract AT(26-1)-99. 102p. Dep. CFSTI.

Results are presented on field investigations of two earthquakes in Colombia, and one in Venezuela in 1967. The first, which occurred on February 9 and had a Richter magnitude of 7.3 to 7.5 (U.C.), was centered near Neiva in southern Colombia. On July 29, two earthquakes occurred. The first, near Bucaramanga, Columbia, at a Richter magnitude of 6.1 to 6.3 (U.C.), caused 20 deaths and $2 million damages (U.S.). The second, near Caracas, Venezuela, had a Richter magnitude of 6.3 to 6.5, caused over 250 deaths, the total collapse of four high-rise structures and partial collapse of another, and damage amounting to about $50 million (U.S.). Close-in damage was concentrated in adobe or masonry low-rise structures; damage at great distances occurred in high-rise buildings, although high-rise buildings were also badly damaged in Caracas from the relatively close-in earthquake of July 29. Churches were damaged both close in and at large distances. Comparison is made between one Bogota ground motion response spectrum from the Bucaramanga earthquake with those predicted for various yields at about the same range. The earthquake spectrum is similar to the predicted spectra for 10 and 20 megatons in the short-period range (less than 0.6 seconds) and with the predicted spectrum for 5 megatons in longer periods (more than 0.6 seconds). (auth)

39964 (ORNL-TM-2210) COMPUTER PROGRAM FOR INBRED AND/OR HYBRID ANIMAL BREEDING AND PRODUCTION COLONIES. Bishop, B. S. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center); Hanna, M. G. Jr. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 145p. Dep. CFSTI.

Five computer programs were developed to process records on animal breeding and production colonies. The programs provide means for creating and maintaining complete master records on the lineage and current status of the colonies and for, listing as output, supervisory action that has been taken as well as maintenance duties that should be performed. The programs were written in the COBOL language for the IBM-7090 computer. (auth)

39965 (PRNC-112) PUERTO RICO NUCLEAR CENTER TENTH ANNIVERSARY. SYMPOSIUM ON NUCLEAR ENERGY AND LATIN AMERICAN DEVELOPMENT, OCTOBER 30-31, 1967. (Puerto Rico Nuclear Center, [San Juan]). Contract AT(40-1)-1833. 166p. (CONF-671053). Dep. CFSTI.

The problems faced by Latin America in areas of food supply and nutrition, public health and medicine, economic and social development, and power and water supplies are reviewed, and the role of nuclear energy in helping solve these problems is examined. Various nuclear programs and nuclear energy applications in Latin American countries are discussed, and energy and material resources, including reserves of uranium and thorium ores, are tabulated. (H.D.R.)

39966 (RFP-1040) ZEHENDER TECHNIQUE FOR SURFACE-ROUGHNESS MEASUREMENT. Utley, L. William (Dow

Chemical Co., Golden, Colo. Rocky Flats Div.). May 17, 1968. Contract AT(29-1)-1106. 12p. Dep. CFSTI.

The Zehender theory and technique of surface-roughness measurement using a replica film of the surface is described. The technique utilizes the interference method of measuring surface roughness but, unlike existing interference methods, provides a means of measuring surface irregularities up to about 20 microns deep. As in the interference method, a three-dimensional picture of the surface is obtained. Since film impressions produce accurate replicas, the Zehender technique can be extended to examine surfaces that would be inaccessible to an interference microscope. The accuracy and precision of the Zehender technique are within 10 percent of the roughness in the range of 10 to 200 microinches, arithmetic average (AA). A commercially available Zehender system is evaluated. (auth)

39967 (RISO-177) ERROR INDICATORS FOR THE NUMERICAL SOLUTION OF NON-LINEAR WAVE EQUATIONS. Kofoed-Hansen, O. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1968. 36p. Dep.

A methodical approach to the problem of error accounting during numerical solution of non-linear wave equations considered as initial value problems is presented. The errors resulting from numerical differentiation are described by the term average modal error indicators. The errors consist of round-off errors, which are treated statistically, and truncation errors, which are treated analytically by the usual methods. The error resulting from integration procedures is described by an error accumulation equation carried parallel to the development of the solution. Source terms for this equation are derived by means of the average modal error indicators for differentiation combined with the coefficients in the expansion and the remainder terms omitted by the truncation of the Taylor expansion. This truncation is also used for the determination of the (variable) step length along the path of integration. A series of simplifications are introduced in order to facilitate the error accounting, and practical procedures are described. The statistical treatment of the round-off errors offers an interesting illustration of the problems encountered in statistical descriptions of completely predetermined systems for the general case where information is lost. (auth)

39968 (RISO-M-719) HDT: HYBRID DEBUGGING TAPE FOR PDP 8. Poulsen, N. J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1968. 33p. (R-10-68). Dep.

The program simulates a PDP 8 interface system. Instead of data being transferred through this interface, the communication takes place between the PDP 8 and the Teletype. This means that a hybrid program can be debugged (not run) on any PDP 8 without interference equipment being required. A simplified version of ODT-II is included in HDT. (Denmark)

39969 (UCRL-17767) COMPILATION OF SELECTED THERMODYNAMIC AND TRANSPORT PROPERTIES OF BINARY ELECTROLYTES IN AQUEOUS SOLUTION. Chapman, Thomas W.; Newman, John (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 297p. Dep. CFSTI.

Data from the literature on properties of binary electrolytes in aqueous solutions are tabulated. The properties include the density, the viscosity, the conductivity, the transference number, the diffusion coefficient, and the activity coefficient. (auth)

39970 (UCRL-18229) FAR-INFRARED SPECTRA OF Al_2O_3 DOPED WITH Ti, V, AND Cr. Joyce, R. R.; Richards, P. L. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 24p. Dep. CFSTI.

The absorption spectrum of samples of Al_2O_3 doped with Ti, V, and Cr was measured at 4.2°K over the frequency range from 5 to 120 cm^{-1}, in applied magnetic fields up to 55 kOe. In Al_2O_3 : Ti absorption lines were observed at 37.8 cm^{-1} and 107 cm^{-1}; these were due to transitions between the ground and first excited states of the Ti^{3+} ion in a modified Al_2O_3 crystalline field. The Zeeman splitting of the observed lines yielded $g_{0\parallel} = 1.11 \pm 0.03$, $g_{1\parallel} = 2.00 \pm 0.06$, and $g_{0\perp}$, $g_{1\perp} < 0.1$ for the ground and first excited states. Similar results were observed from the isoelectronic V^{4+} ion in the Al_2O_3 : V sample. Zero field absorption lines were observed at 28.1 cm^{-1} and 53 cm^{-1}, with g-values for the ground and first excited states of $g_{0\parallel} = g_{1\parallel} = 1.43 \pm 0.04$ and $g_{0\perp}$, $g_{1\perp} < 0.2$. The predicted energy levels of a single d electron in the Al_2O_3 crystalline field modified by a dynamic Jahn-Teller effect fit these data quite well. An absorption line observed at 8.25 cm^{-1} in Al_2O_3 : V was attributed to the spin-orbit splitting of the lowest electronic state of the V^{3+} ion. The Zeeman splitting of this line is in excellent agreement with the appropriate spin Hamiltonian with the parameters $g_{\parallel} = 1.92 \pm 0.03$ and $g_{\perp} = 1.74 \pm 0.02$. A 15-cm length of 1% Al_2O_3 : Cr showed no absorption lines for any value of magnetic field, indicating that the transitions between the Cr^{3+} ion pair levels known to exist in this energy region are strongly forbidden. Samples of ruby reported to show far-infrared absorption lines were tested, and it was found that the splitting of the observed lines in a magnetic field was consistent with the assumption that they were due to Ti^{3+} as an unintentional impurity. (auth)

39971 (UCRL-50406) AUTOMATED ACQUISITION, CATALOGING, AND CIRCULATION IN A LARGE RESEARCH LIBRARY. Boylan, Merle N. Jr.; Crocker, Elizabeth L.; Verity, John B.; Buginas, Scott J.; King, Jack L.; Woinowsk, Orrine (California Univ., Livermore. Lawrence Radiation Lab.). May 1, 1968. 94p. Dep. CFSTI.

Automated library procedures developed at Lawrence Radiation Laboratory, Livermore, are fully operational — some have been in use for over three years. The systems' features include: charge out and discharge, maintenance of reserve lists, provisions for statistics and inventory control, and the production of: availability notices, recall notices, purchase orders and claims, sorted printouts of acquisition data, announcement bulletins, and separate printed catalogs for books and documents. Printed catalogs for books permit access by author, title, subject, and call number. Those for documents index by personal author, corporate author, title, subject, contract number, report number, and accession number. Approximately 80% of one non-prime shift on an IBM 1401 8K is required for the programs, with some sorting being done on an IBM 7094, and some printing done on a Radiation Inc. high speed printer. (auth)

39972 (UCRL-70910) COMPUTER-AIDED CIRCUIT LAYOUT AND DESIGN. Martin, L. C. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 18p. (CONF-680707-1). Dep. CFSTI.

From 5th Annual Design Automation Workshop Conference, Washington, D. C.

The general features of PUZZLE, a FORTRAN IV program for the design and layout of electronic circuits, are described. (B.G.D.)

39973 (Y-1615) A USERS MANUAL FOR HANDY, A FORTRAN IV PROGRAM FOR CALCULATING NUMERICAL COEFFICIENTS OF THE GENERAL SECOND-DEGREE EQUATION IN THREE VARIABLES. Handley, G. R.; McLeod, J. N. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). June 19, 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

HANDY is a FORTRAN IV program which calculates the coefficients of the ten terms of the second-degree or quadric equation in three variables. A users manual is presented which describes in detail the format of the input data required; and, as an aid to understanding the data, the input and output of a sample problem are included. (auth)

39974 SOLID STATE PHYSICS, NUCLEAR PHYSICS, AND PARTICLE PHYSICS. Ninth Latin American School of Physics Held in Santiago, Chile, July 1967. Saavedra, Igor (ed.). New York, W. A. Benjamin, Inc., 1968. 859p. $16.00. (CONF-670728).

Separate abstracts were prepared for 10 of the 14 papers included. The four remaining papers deal with the electrodynamics of solids, the electronic structure and optical properties of insulators, the electronic optical properties of solids, and critical phenomena in Heisenberg models of magnetism. (D.C.W.)

For abstracts of individual papers see: 38779, 39309, 39337, 39368, 39385, 39443, 39444, 39475, 39476, and 39565.